Report of the Community-Wide Workshop on NASA's Space Physics Data System

December 1993

Prepared for:

Space Physics Division
Office of Space Science

Table of Contents

EXECUTIVE SUMMARY

Approximately 75 scientists gathered for a community-wide workshop on the Space Physics Data System (SPDS) in early June at Rice University, Houston. The workshop considered community needs for access to data and made recommendations to guide NASA's Space Physics Division (SPD) in managing space physics data in the 1990s and beyond. It was organized around four panels (Policy, Data Issues, Data Systems, and Software). Participants were asked to review the SPDS Concept Document (prepared by the SPDS Steering Committee) and to register either approval or an alternative view to any or all the ideas discussed in the document, through one or more of the appropriate panels. In addition, the panels were charged to identify and prioritize key requirements in their area of interest and to comment on relevant issues of implementation.

The resulting recommendations from the four panels are broadly consistent in the overall sense of an SPDS in areas of joint interest. The panel structure worked well in facilitating a combined set of recommendations that constitute a major step forward to define the scope and an approach to SPDS that would most effectively support the NASA space physics research community while still being realistic in an austere budget environment.

The following are the key "policy-level" observations and recommendations of the workshop:

(1) It was agreed that the creation of an SPDS would help fulfill the urgent data exchange requirements presented by upcoming new missions, as well as preserve and improve access to critically important data sets from both past and present programs. SPDS should support all four SPD branch user communities (Cosmic and Heliospheric Physics; Solar Physics; Magnetospheric Physics; and Ionospheric, Thermospheric, and Mesospheric Physics) in ways appropriate to each of those communities. The SPD should initiate the SPDS now, in spite of very limited funding. As the scientific productivity of SPDS is demonstrated and recognized by a broader scientific community, NASA will need and ought to provide significant new resources to the Division to support SPDS.

(2) The five functional objectives identified in the SPDS Concept Document are appropriate, namely:

- to curate data sets important to current or future research;
- to provide information about space physics data sets to potential users;
- to provide efficient access to the data and ancillary information;
- to enable cost-effective and efficient analysis of data; and
- to act as a focus for the evaluation and introduction of effective new data technologies into space physics.

The most important SPDS objective now however should be to provide the scientific research community with access to high quality data products. Support for the dissemination of data analysis tools is important but of secondary priority. Awareness of recent development in data management technologies is important for SPDS but is the lowest of the five functional objectives.

(3) The workshop endorsed the Concept Document's emphasis on a distributed data system designed, developed, and operated by scientific users of space physics data. The SPDS should make maximum use of existing facilities including data centers, project data management units, individual centers at Principal Investigator (PI) institutions, and existing computer networks. The current paradigm

envisions use of the NASA Master Directory to indicate what data are available and where, the use of existing software and human systems to retrieve data, and the uses of data format translators to import data into an investigator's own analysis system. Funding should be awarded competitively through peer review. In the initial stage, this could be through an augmentation or supplement to scientific investigations selected under existing peer review programs.

(4) Consistent with a philosophy of a grass-roots effort built from existing capabilities and operating as a community-distributed service, SPDS should emphasize the concept of "coordination" and "coordinators" as a management approach to accomplish its larger goals. Initially, there should be Project Coordinator(s) and Discipline Coordinator(s) representing each of the four Space Physics Division branch-discipline user communities. The Discipline Coordinators should be scientists within their community who presently work with, and exchange, data. The Project Coordinator(s) will provide contact between the SPDS and other NASA data systems activities, with other government agencies and the international community as well as work with the Discipline Coordinators. Formal SPDS management authority should remain with MO&DA Program of the Division. It was suggested that a follow-on SPDS Users' Workshop should be held in about a year.

(5) Participation in SPDS by all current and future division-related investigations, and their Principal Investigators (PIs) during the active phase of missions, should be encouraged. This will require recognition of rights of PIs to a period of exclusive use of the data from their instruments.

The workshop panels also made specific recommendations in their specific areas of interest to both requirements and implementation. Highlights and recommendations from the individual reports (grouped by panel) are:

(6) In the area of Data Issues:

(a) For SPDS to be effective, a listing of all data sets that are available is needed. Catalogues should contain information concerning the instrument, satellite, format of the data, a timeline of instrument and satellite events, and the location of the ephemeris. Directories should serve as pointers to distributed inventories in a standard format, that contain sufficient information to characterize the data holding to allow the average researcher to decide whether they are appropriate and if so, to identify the parts of the data that meet his/her particular requirements.

(b) To include a maximum number of participants, the use of the SPDS should require only widely available technology and hardware and should need minimal technical knowledge of computer systems. There should be few "requirements" to which data suppliers or users would need to conform. However, there should be many "suggestions" which can be used to guide those who wish to participate.

(c) Some criteria for determining which data sets should be a part of SPDS include: uniqueness, the difficulty with which they were obtained, and their potential for being lost. However, the primary criterion must be heavy use or the possibility of heavy use. Archiving and documenting data sets must generally assume priority over improving formats or placing data sets on-line. Archiving Level 0 data is highly desirable.

(d) The curatorial role of the original institution where the PI is (was) affiliated should be recognized and developed. SPDS should investigate the use of universities and institutions which have mechanisms that are designed to provide long-term curation of scholarly data bases and raw research materials in other disciplines such as libraries and museums.

(e) SPDS should include non-NASA data sets such as those funded by NSF, DoE, other federal institutions, and universities. Both US and non-US data suppliers and users should be included. The needs of developing nations should be considered.

(7) In the area of Data Systems:

(a) The critical system functionalities identified for SPDS are: the delivery of self-documenting data; the existence of a matrix of translators between several standard formats; and a network-based capability for browsing and examining inventory records for the system's data holdings.

(b) Considering the austere funding environment, as well as the diversity of systems in place at the nodes listed in the concept document and potential subnodes, the panel specified as system level standards only TCP/IP network interfaces and the seven file formats identified in the Concept Document as initial system-wide standards. The overriding consideration for any SPDS interface should be ease of use by a technically competent investigator. As an aid to SPDS nodes developing appropriate software interfaces, the space physics community should be polled on such subjects as preferred interface, monitor display capabilities, data analysis software of choice, and available data communications. SPD should express its support for NASA's efforts to lead in the implementation technologies, such as ATM, that would significantly increase the bandwidth of data communications with currently bandwidth-limited sites.

(c) NSSDC besides continuing its traditional roles as a Master Directory server, central data copying facility, and deep archiving facility, should also serve the SPDS user community by providing a bulletin board and/or mailing list for announcements of general interest, and anonymous FTP services for data format translators, models, and other software tools of general interest.

(8) In the area of Software:

(a) The SPDS should state a policy that new application development should meet some minimum standards. Adherence to this policy should become a contractual obligation. However, it is also believed that NASA's current software development policy imposes too much overhead on software projects.

(b) NASA should provide funding to extend and enhance existing systems to meet its requirements and needs. If no software currently exists that can meet specific SPDS needs, then development of new software should be funded. SPDS should encourage the sharing of existing software and actively work to make it easier to obtain existing software. Freely distributed software was considered a high priority activity, but the choice of Commercial Off-The-Shelf (COTS) software should be left up to the individual. It was also noted that no COTS technology assessment group should be a part of the SPDS.

(c) A catalog of existing software should be implemented. Providing direct access to a central repository (library) of software is as not important as a catalog. Software should include data processing, translation, analysis, and visualization routines, and could include ancillary software such as models, simulation results, etc. Acting as a software repository is not considered as high a priority as dissemination of information, comments, and experiences.

(d) NASA should assume a capital equipment responsibility and provide funds to insure that the research community has a computing environment that does not limit the general distribution, use, and development of software systems. However, the current hardware and operating system market is not sufficiently stable nor influenced by the SPDS community by itself to the extent that choosing a standard platform would be viable. It is recognized that the current trend is towards UNIX systems that run X-windows on a variety of architectures and Windows-NT running on Intel architectures. The emphasis should be on developing portable code so that it may easily be migrated as new technologies are introduced.

Since the workshop and in direct response to its recommendations, the Space Physics Division has called for volunteers and now named an “SPDS Coordinators” Working Group (SPDS/CWG) that will be composed of:

- an SPDS Project Scientist,
- four SPDS Lead Discipline Coordinators, and
- two SPDS Project (Co-)Coordinator(s).

The Lead Discipline Coordinators will be supported by four Discipline Coordination Teams composed of volunteers from their communities. The Lead Discipline Coordinators will represent the Teams on the SPDS/CWG. The SPDS/CWG has the broad responsibility to move the definition of an SPDS program forward from the Concept Document and the recommendations of this workshop, to start a first working version of SPDS and to serve as focal points for advertising SPDS, compiling and disseminating information about available data and data access, and establishing a beginning set of “rules of the road” for data exchange.

The prototype SPDS demonstration developed for the workshop remains operational and accessible through the NASA Master Directory. In addition information about SPDS, its status and additional prototyping work is available as an option of the joint NSSDC-SPDF “NODIS” guest account. The workshop participants in the data systems panel also defined an experiment they would undertake to see whether DITDOS, an inventory tracking system developed by PDS, could be used easily and inexpensively to manage existing space physics inventories. The CEDAR project inventory established at NCAR was selected as a test case. The Institute of Geophysics and Planetary Physics (IGPP) at UCLA has established a list server to serve the SPDS community as a forum for discussing SPDS related issues.

1. INTRODUCTION

On June 1–3, 1993, a space physics community-wide workshop on NASA's Space Physics Data System (SPDS) was held at Rice University in Houston, Texas. The workshop was sponsored by the Mission Operations and Data Analysis (MO&DA) program of the Flight System Branch of the Space Physics Division of the Office of Space Science.

The meeting was attended by seventy five individuals representing the National Aeronautics and Space Administration (NASA), the Department of Energy (DoE), the National Oceanic and Atmospheric Administration (NOAA), academia and private industry. The list of attendees is provided in Appendix A.

There have been many studies and reports in recent years that have played important role in addressing data management environment of NASA. From the Committee on Data Management and Computation (CODMAC) reports [1-2] in the 1980's to the more recent General Accounting Office (GAO) reports [3-4], and ongoing initiatives in Data Management, and High Performance Computing [5], attention is being focused on meeting increasingly demanding user needs and ensuring preservation of critical data within limited budgets. The new data management policy stresses the importance of data management planning and addresses the complete life cycle of data from initial collection and processing through permanent archiving.

The workshop agenda (see Appendix B) included an introduction to the charge of SPDS, an overview of the SPDS concept, lessons learned from existing discipline data systems, the progress made by space physics disciplines data evaluation panels for data sets archiving and restoration, and poster presentations and demonstrations of space physics data systems existing in the community now. In addition to demonstrations of the existing data systems, demonstration of the proof-of-concept system was also given. The abstracts for poster presentations and data systems demonstrations are provided in Appendix C.

To facilitate an organized discussion of the issues surrounding the potential creation of a new data system, this workshop was organized as a set of four panels: the first panel (Policy Panel) was to define the attributes of SPDS and to consider management issues; the second panel (Data Issues Panel) was to address issues of data archiving and restoration, mission interfaces, data access, data curation and data distribution; the third panel (Data System Panel) was to deal with user interfaces, data formats, data standards and cataloging functions; and the last panel (Software Panel) was to address support of data analysis and data visualization. The members of different panels in the first panel session are provided in Appendix D. Each workshop participant was asked to participate in one or more of the panels. The agenda included generous opportunity in plenary sessions for cross-panel comments and discussion.

The need for the Space Physics Data System is well documented in [5-7]. The functional objectives of SPDS are to:

- Curate data sets important to current or future research
- Provide information about space physics data sets to potential users
- Provide efficient access to the data and ancillary information
- Enable cost-effective and efficient analysis of data

- Focus on evaluating and introducing effective new data technologies into space physics.

Each participant was asked to review the SPDS Concept Document [6] and to register either approval or an alternative view to any or all concepts discussed in the document, through one or more of the appropriate panels. In addition, the panels were charged to identify and prioritize key requirements in their area of interest and to comment as thought necessary on relevant issues of implementation.

The charges for the workshop and individual panels are described in Sections 2 and 3, respectively. Section 4 deals with detailed recommendations of each panel. In Section 5, a summary of recommendations is provided.

2. WORKSHOP CHARGE

The Space Physics Division (SPD) is seeking guidance from the space physics community concerning the currently most important data management needs. In order to accomplish this, the charge of the community-wide workshop was to :

- Gather community comments on the needs to be satisfied by an SPDS and on the system concept as now proposed;
- Better expose data services already operating to serve the space physics community as a pre-SPDS; and
- Kick off an ongoing SPDS Users Working Group.

The SPD is also trying to determine from the community-wide SPDS workshop:

- What additional investments, if any, are appropriate to make in restoration, preservation, improved accessibility, and/or improved distribution of space physics data sets to the space physics community; and
- To what extent an appropriately defined SPDS should be a part of any such investments.

The goal for this workshop is to develop concise and well written recommendations, which can then collectively serve as a guide to SPD in defining an optimal level of commitment and directions in managing space physics data in the 1990s and beyond.

3. CHARGE FOR INDIVIDUAL WORKSHOP PANELS

The charges listed in this section for each of the panel were provided for the purpose of guidance only. Each panel chair was given freedom to accept all or any or none of the charges or to add new charges as he or she deem necessary.

3.1 Policy Panel Charge

The Policy Panel was to consider whether SPDS is an appropriate direction to follow, what the overall definition, scope, and attributes of SPDS should be, and to develop recommendations for participation in and management of SPDS if formed.

The Policy Panel was requested to consider addressing the following questions:

(1) Is there a need for overall NASA space physics data management activities beyond the existing NASA SPD requirements and practices to archive/curate data at the National Space Science Data Center (NSSDC) and baseline data information services available in the NASA Master Directory (NMD) and other NSSDC-operated systems?

(2) If there is need for an enhanced emphasis on space physics data management, is an SPDS an appropriate approach to organizing and implementing such a thrust?

(3) If an SPDS is reasonable, do the existing Concept Document define an appropriate and reasonable outline for such an SPDS? In particular, what sections need what major modifications, deletions or additions and what changes specifically?

(4) What should be the relative priorities among the five major objectives defined for SPDS in the Concept Document?

(5) How should the technology information element of the SPDS objectives be addressed organizationally?

(6) If the distributed architecture proposed in the current Concept Document is believed appropriate, what is the best way to define a long-term structure (by space physics disciplines, by project, other)? Is an Announcement of Opportunity (AO) or NASA's Research Announcement (NRA) process appropriate to selection in the development and/or operations phases? What are the criteria on which nodes should be selected, and how should project-developed data centers be folded into this process? How permanent should nodes be, and how/when or should SPDS and/or project nodes be declared obsolete and removed? How do we transfer the responsibilities of obsolete nodes to another organization if required? The Policy and Data Systems Panels should investigate this early in the deliberations.

(7) Are there recommendations as to the appropriate level of SPD financial commitment to SPDS {i.e., in total funding per year and/or as percentage of the overall MO&DA budget and/or in size relative to Guest Investigator (GI) or equivalent program to support space physics research}?

(8) What is an appropriate philosophy for managing SPDS?

(9) Should SPDS develop or endorse standards (e.g., data formats, documentation, software, network communication, etc.) for space physics data? How important are the standards? If so, how should standards be adopted and enforced? What is the relative importance of data preservation activities, data access and distribution activities, and data analysis tool building activities?

3.2 Data Issues Panel Charge

The Data Issues Panel was to address requirements, priorities, and the appropriate role of an SPDS in archiving, restoring, distributing, facilitating access, and curating space physics data products from past, present, and future missions.

The Data Issues Panel was requested to consider addressing the following questions:

(1) What level of involvement in data archiving, restoration, and curation is appropriate for SPDS? What should be the relative roles of NSSDC and the SPDS in data archiving, restoration, and curation? What data should be archived? When data should be restored and discarded, who will be responsible for data curation?

(2) Should data from active missions become a part of SPDS, and if so, when and how should that occur?

(3) What criteria should be used in prioritizing data sets for archiving? What proportion of effort should be spent in long-term archive of unique but little used data versus more current and heavily used data?

(4) What are reasonable standards for useful documentation? What level of standardization in the form and review of documentation is appropriate and likely to prove cost-effective as an SPDS requirement?

(5) How intensive should the data restoration process be? What are the criteria for different restoration efforts?

(6) How important is the maintenance of an expert infrastructure in the relevant Principal Investigator (PI) community to support best use of key data sets by SPDS users?

(7) At a given resource level, is archiving more data, better documenting data, archiving data in more standard formats, or maintaining more data on-line/near-line most important to enhanced scientific productivity?

(8) Do we need to archive level 0/1 data? What fraction of resources are appropriate to make such data useful beyond the immediate PI and his/her collaborators if such data is held archivally?

(9) Can we really afford to put all the data in a standard format? Should the SPDS subscribe to data format standards?

(10) How much catalog information is required?

3.3 Data Systems Panel Charge

The Data Systems Panel was to define the requirements for SPDS user interfaces, data formats and standards, technologies and standards for implementation, other common system elements (e.g., cataloging and directory functions) and general issues of system engineering.

Considerable interaction of the Data System Panel with the Policy and Data Issues Panels was necessary in order to adjust to any recommendations that change the nature of the SPDS as described in the Concept Document.

The Data Systems Panel was requested to consider addressing the following questions.

(1) What are the critical functionalities needed for SPDS?

(2) Should the SPDS subscribe to systems level standards? Should there be alternatives? What are the advantages and disadvantages of those standards? Both the Data Systems and Software Panels were asked to comment on this.

(3) What should be the role or utilization of NSSDC services?

(4) What is the required functionality for directories, catalogs, and inventories etc. in SPDS?

(5) How distributed should the functions of SPDS be? When it is best to have a distributed system? When it is best to have a centralized system? When it is best to have a distributable system?

(6) How important is a common user interface to SPDS? What should be the high level user interface requirements? What kinds of interoperability among the nodes is likely to significantly enhance space physics science productivity?

(7) What roles (if any and when) should SPDS have as a space physics data technology "clearing house?"

(8) Is there any other hardware and other facility support (e.g., further enhancements to network connectivity and bandwidth, particularly at small and/or isolated space physics sites, supercomputer access etc.) that should be defined as SPDS implementation priorities?

(9) Comments on the pluses and minuses of the systems seen in the demonstrations. Are any of these systems, or part of them, particularly appropriate to be considered as components and building blocks of SPDS? The Data Systems and Software Panels were asked to consider evaluating the approaches and comment on the demonstrated systems.

3.4 Software Panel Charge

The Software Panel was to define the appropriate requirements and priorities (if any) for SPDS to support common data analysis and data visualization software tools and packages.

Considerable interaction of this Panel with the Policy, Data Issues, and Data Systems Panels was necessary so that this Panel can adjust to any recommendations that change the nature of the SPDS as described in the Concept Document. The Software Panel was asked to help other Panels to scope their recommendations by providing advice on how difficult it would be to carry out a given recommendation.

The Software Panel was requested to consider addressing the following questions:

(1) Should the SPDS provide an on-line library of existing software developed by SPD programs? How should this software be cataloged? What software and documentation standards should apply? The Software Panel should get feedback from Data Issues and Data Systems Panels on this.

(2) Should the SPDS develop new software to support data analysis and/or data visualization? What software and documentation standards should apply? How should this software be managed and distributed? What other kinds of new software should be developed? The Software Panel should get feedback from the Data Issues and Data Systems Panels on this.

(3) Consider a software toolbox to help investigators prepare data for archiving and for users access of data. If the software toolbox support is recommended, what should the toolbox contain, in a generic sense?

(4) Report on the software aspects of the workshop demonstrations.

- What are the desirable features or products for SPDS to consider?

- What features or products does SPDS not want to consider?

(5) To the extent there is a software tools support element in SPDS, should the strategy aim to sponsor development of tools that could then be freely distributed or define a framework that emphasizes increasing reliance on Commercial Of The Shelf (COTS) software? Is there a need for SPDS to act as a software information clearing house?

(6) Is there a need to define a standard platform or platforms that will be the focus for any SPDS software support and what should they be (e.g., POSIX/UNIX with X as a standard, PC-DOS in or out of the range of platforms as a priority for support)? If standards are defined, how important as a funding priority should it be to bring access to a standard platform to all active members of the space physics community?

(7) What should SPDS policy with respect to common formats be? What are the technical issues?

4. WORKSHOP RECOMMENDATIONS

4.1 Policy Panel Recommendations

The recommendations made by the Policy Panel are the following:

Should there be an SPDS?

Making space physics data broadly and readily accessible for scientific inquiry is an activity in which the space physics community is currently engaged and which is a necessary component of a viable, modern research activity. Recognizing these activities collectively as the "Space Physics Data System" (SPDS) is most appropriate.

What should the philosophy of the SPDS be?

The SPDS should be a distributed data system designed, developed and operated by scientific users of space physics data. SPDS should make maximum use of existing facilities including data centers, project data management units, and individual centers at principal investigator institutions. SPDS should be implemented through existing computer networks using appropriate standards and software.

What is the appropriate funding level and how should SPDS funding be related to funding levels of other SPD activities?

The SPDS should serve to enhance the data analysis environment of researchers in the field. However, at the present time, the entire data analysis effort within SPD is seriously underfunded. Significant future funding for SPDS should represent new resources, made available to the Division to support the Division Data System in a move toward achieving parity with other Divisions, which already have been given large Data System resources.

The need for an SPDS is real and urgent. Therefore, we urge the Division to initiate the SPDS now, with existing (albeit limited) funding. As the utility of the SPDS grows and is recognized, funding should grow appropriately. The ultimate funding level should be determined by the value of the user-evolved SPDS to the community, and may well turn out to be of the same level as now exists in the Solar System Exploration and Astrophysics Divisions.

If there is funding, how should it be distributed to the community?

Funding should be awarded competitively through peer review. In the initial stage, this could be through an augmentation or supplement to scientific investigations to be selected under existing peer review programs. In anticipation of future increases in funding, support could then be distributed through a separate AO.

In the current austere funding environment, what should the SPDS look like?

The paucity of funds makes it impossible to incorporate the diverse data sets into a comprehensive system. The current paradigm must therefore be reliant on the Master Directory to indicate what data are available and where they are located, the use of existing software and human systems to retrieve data, and the uses of data format translators to import data into an investigator's own analysis system.

What are the important objectives of an SPDS, and in what priority?

Access to quality data is the most important objective, with curation and information about the data being integral parts of any accessible data set. As pointed out in the Concept Document on NASA's SPDS, support for dissemination of data analysis tools is important but of secondary priority to the above three objectives. Awareness of recent developments in data management technologies is important but of lowest priority of the five objectives.

What next? How should an embryonic SPDS be structured to continue the activity, in the current climate?

The management structure is expected to evolve as the SPDS becomes better defined. Initially there should be a volunteer Discipline Coordinator from the user community for each of the four SPD branches and a Project Coordinator (s). The Coordinators will survey and inform their communities and begin SPDS activities. A follow-on users community workshop should be planned for about one year from now.

What should be the relationship between SPDS and network services?

The success of SPDS depends upon the existence of a reliable, high-speed, worldwide, and multi-protocol communications network.

What should be the relationship of SPDS to new projects and proprietary data?

Participation in SPDS by all current and future division-related investigations, and their PIs during the active phase of missions should be facilitated. This requires recognition of and adequate safeguards for the protection of data as long as they remain proprietary. The SPDS should be structured to permit the dissemination of proprietary data to team members and guest investigators, and to allow for easy migration of data into the public domain.

Should SPDS support the software library?

A software library catalog that indexes into software distributed across the network should be an integral part of SPDS. Software should include data processing, translation, analysis, and visualization routines, and could include ancillary software such as models, simulation results, etc.

What should be the relationship between the SPDS and existing information services activities {e.g., NSSDC and Space Physics Data Facility (SPDF)} within space physics?

Existing NASA data services provide for deep archiving (a permanent repository), access for international collaborators, broad cataloging and directory services, and Division-wide coordination (e.g., Satellite Situation Center (SSC)) through the NSSDC. These activities are an important part of SPDS and continuation of NSSDC as one of the SPDS nodes is highly recommended.

4.2 Data Issues Panel Recommendations

The Data Issues Panel started with a set of assumptions that were generally considered by the members but not specifically debated. These general assumptions formed a framework upon which the discussions of specific issues were based.

(1) SPDS is a good idea and should exist.

(2) It should not be ambitious but rather should start by formalizing the informal systems that already exists.

(3) The first goal of SPDS should be to facilitate the exchange of useful data between scientists with greater ease. This will maximize scientific output. The initial effort would be voluntary.

(4) The SPDS should be accessible and usable by as many people as possible. Both US and non-US data suppliers and users should be included. The needs of developing nations should be considered. The SPDS should include:

  (a) Non-NASA data sets such as those funded by the National Science Foundation (NSF), the Department of Defense (DoD), other federal institutions, and universities.

  (b) A maximum number of participants, the use of the SPDS should require only widely available technology and hardware and should need minimal technical knowledge of computer systems.

The SPDS should encourage wide participation, there should be no undue burdens on data suppliers or system users. There should be few requirements to which data suppliers or users would need to conform. However, there should be many suggestions that can be used to guide those who wish to participate.

(5) There should be **"rules of the road"** that allow PI's or curators to both control and facilitate access to and use of the data. These rules may vary for different data sets.

(6) Documentation should be available for all data and should be as thorough as possible. The level and completeness of documentation will also vary among data sets.

The Panel considered the first steps toward a Space Physics Data System. The Panel envisions that an early incarnation could begin to develop even in the absence of any funds through voluntary effort.

Minimum Requirements for SPDS

(1) There must be a centralized listing of all data sets that will be a part of the SPDS. This listing should include data sets that exist at host institutions and are off-line. The listing should be kept current. It should include the following items, at a minimum:

  (a) Source of data (e.g., Spacecraft (S/C), ground station, etc.)

  (b) Type(s) of measurement (e.g., magnetometer, particle telescope, etc.) and parameters available (e.g., flux, moments, etc.) and their units.

  (c) Time span of data and information on nature of data coverage (e.g. complete polar passes only, etc.)

(d) Volume of data set

(e) Ephemeris data location (if not contained in the data set)

(f) Cognizant personnel (Principal Investigator (PI), curator)

(g) Means of access and delivery (e.g., on-line, Compact Disc-Read Only Memory (CD-ROM) near-line, magnetic tape, [punched cards?], etc.)

(h) Formats

- Abstract of data description
- Available software to read and/or display data set
- Software to translate the data set into a standard format, if necessary
- Detailed format description.

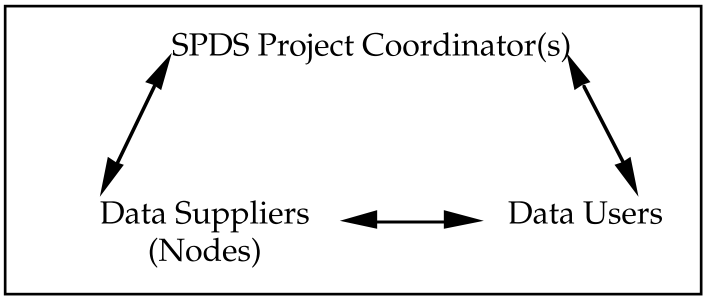
(2) It will be the curator's responsibility to maintain and extend the data set, notifying the SPDS Project Coordinator of any and all changes to the data set, including new data, re-calibrated data, etc. These changes will be passed on to the user community.

(3) In the event that a data set is endangered, either through loss of funding, or lack of cognizant personnel, or deterioration of media, etc., the SPDS Project Coordinator shall communicate this to the entire SPDS community, and identify means of saving it, if possible and determining whether the data set is considered important.

(4) A means of controlled access must be established so that a PI's proprietary rights to the data are respected.

The Structure and Layers of SPDS

The SPDS is a grass-roots effort defined by the following structure. Each layer of the SPDS is described by that element's functions, responsibilities, and requirements:



(1) Project Coordinators and Discipline Coordinators:

Ideally, Project Coordinators (PCs) and the Discipline Coordinators (DCs) are scientists within the community who are presently engaged in proto-SPDS activities. A possible structure would be one overall Project Coordinator, assisted by four Space Physics Branch Coordinators. Initially, these might be voluntary and rotating positions.

The Project Coordinators will be charged to:

- Advertise to the appropriate community the existence, mission, and operation of the SPDS
- Compile information provided by SPDS data nodes regarding data and generic software, availability, points of contact, access, etc., and to disseminate these inventories to the community
- Establish rules of the road for data exchange and SPDS participation
- Encourage SPDS-like activities within non-NASA agencies and the international community.

The Discipline Coordinators will be charged to:

- Play an active advisory role in data systems requirements for future missions.
- Monitor system use and track data distribution (retain log of users as well as nodes)
- Identify possible duplication of effort (provide information on the official approved repository in the event of discrepancy)
- Notify users about data set additions (subtractions), system changes, etc. as needed
- Encourage, but not require, community involvement toward developing standards and community-shared efforts
- Identify and support endangered data sets
- Promote communication with other non-traditional agents for data archival/curation (e.g., university libraries).

(2) SPDS Data Suppliers (Nodes):

SPDS nodes will provide:

- A list of data sets available at the node's institution
- Description of how to access available data
- Description of data
- Provide PI/curator supervision and assistance to users if possible, and if desired
- Translation code to access data

- Connection to Internet.

(3) SPDS Data Users:

The SPDS users should:

- Have an Internet connection
- Abide by the rules of the road
- Notify the PI/curator about intentions for data and provide preprints of publications.

The curatorial role of the original institution where the PI is (was) affiliated should be developed and recognized by the space physics community. Since one of the obligations of an archiving system must be to make data available to future generations of researchers, the SPDS should investigate the use of universities and institutions that have mechanisms that are designed to provide long-term curation of scholarly data bases and raw research materials in space physics. A low-cost program that the SPDS office might undertake would entail:

(1) Selling the concept of scientific data curation responsibility to the libraries and museums.

(2) Providing guidelines, documents, software, and other tools to assist libraries in fulfilling this responsibility.

The Panel discussed the questions listed in the Data Issues Panel charge and arrived at the following responses:

(1) The SPDS can supply encouragement, guidelines, and ultimately provide a mechanism for financial support for data archiving, restoration, and curation. The NSSDC is a recognized repository for data archiving. However, where applicable, the PI for the mission, and his current institution should retain his or her data and be responsible for its restoration and curation. Ideally, all data should be archived. However, the restoration and curation of archived data sets will be undertaken by those who have an interest, and the funding, to do so. Orphaned data sets, i.e., data which are no longer supportable by either the PI or his/her institution and are not wanted by any other organization, should be repossessed by the NSSDC which would act as a library for old data sets. The Panel strongly suggested that long-term archiving should include duplicated archives at widely separated sites.

(2) The SPDS should be sufficiently attractive to induce PI's of new missions to join and obtain correlative data sets. PI's may hold proprietary rights over their data sets for periods defined by NASA.

(3) Some criteria for determining which data sets should be restored include: uniqueness, the difficulty with which they were obtained, and their potential for being lost. However, the primary criterion must be heavy use, or the possibility of heavy use.

(4) Files should be self-documenting with enough information to enable scientific use. There should be an option for users to add comments for problems they have come across.

(5) See (4) above.

(6) An expert infrastructure is very helpful in interpreting data sets. However, it must be must recognized that the PI and Co-I's won't always be available. The SPDS nodes should therefore maintain records of related papers and recent data requests to assist future researchers.

(7) Archiving and documenting data sets must generally assume priority over improving formats or placing data sets on-line. The Panel recognized that formats change and the technological advances will make it possible to place large amounts of data on-line in the near future.

(8) Archiving of Level 0 data is highly desirable and should be recommended in order to economically allow for changes in processing routine (software). It is recognized that such data will be accessed in conjunction with a set of processing routines which put the data in suitable units with the minimum loss of time resolution. Lower resolution data along with derived data products may be appropriate in many instances. These will require no additional connections and generally can be used as is.

(9) It is not possible to place all data (particularly older data sets) in a standard format. The Panel expect a gradual evolution to a preferred one or two or more formats. For the foreseeable future, format translators will be required.

(10) Catalogues should contain information concerning the instrument, satellite, format of the data, a timeline of the instrument and satellite events, and the location of the ephemeris.

(11) The Panel brought two additional points:

- If SPDS proves to be cost-effective, it will be in a position to suggest guidelines to NASA for requirements it might impose upon future missions and data sets.

- The Panel reiterated its interest in including non-NASA data sets in the SPDS system [i.e., NOAA, European Space Agency (ESA), ground-based, and DoD data sets].

4.3 Data Systems Panel Recommendations

Given the lack of prospects for any near-term funding sufficient to allow significant enhancements in SPDS capabilities beyond those currently in place, the Data Systems Panel concentrated on maximizing the scientific usefulness of a lean data system. The recommendations made by the Panel are:

(1) Critical Functionalities

The Panel identified three critical functionalities of a Space Physics Data System: the <u>delivery of self-documenting data</u>; the existence of <u>a matrix of translators between various standard formats</u> {Instrument Data File Set (IDFS), Common Data Format (CDF), netCDF, Hierarchical Data Format (HDF), TENNIS, UCLA flat file, and Flexible Image Transport System (FITS)}; and <u>a network-based capability for browsing and examining</u>

inventory records for the system's data holdings. The translators, as well as useful data reduction and analysis tools, should be made available through anonymous File Transfer Protocol (FTP) from central sites. The inventory system would have both central and distributed entry points (with the central node pointing to the latter), with the inventory records at each node or subnode transmitted in a standard format. (This could be a simple ASCII flat file with certain required and optional fields describing the data holdings, data access methods, and points of contact for expert advice on analysis of the data.)

(2) Desiderata

The Panel enumerated additional, desirable capabilities of an SPDS that might be dependent on additional resources: a centralized bulletin board service and or mailing list server for distribution of software updates and data holding news, and data browse and display tools. A Usenet news group could be an effective method of keeping the community up to date with new data sets, software, and hardware available at the various nodes and end-user sites, and would not require moderation. A central FTP service could aid in the distribution of analysis and visualization software — obvious desiderata in themselves — as well as a source for other software and data (*e.g.,* models, educational software, cross-sections, etc.). Whenever possible, such information should be shared with the Planetary Data System (PDS) and the Astrophysics Data System (ADS) communities.

The SPDS nodes should log the usage of various data holdings, and users of those data holdings should be informed of the appropriate wording for acknowledging the support of the node and PI providing the service.

(3) System Level Standards

Once again considering the austere funding environment, as well as the diversity of systems in place at the nodes listed in the concept document and potential subnodes, the panel specified only the Transmission Communication Protocol/Internet Protocol (TCP/IP) network interfaces (Telenet, FTP, Simple Mail Transfer Protocol (SMTP), and perhaps Wide Area Information Server (WAIS), gopher, and similar distributed data access facilities) and the seven file formats listed above as system-wide standards. There would be no impetus (from the SPDS alone) to reformat existing data sets if the matrix of translators existed.

(4) Role of NSSDC

In addition to continuing its traditional roles as the Master Directory server, central data copying facility, and deep archive, the NSSDC can also serve the SPDS user community by providing a bulletin board and/or mailing list for announcements of general interest, and anonymous FTP services for data format translators, models, and other software tools. The NSSDC could also be used to help establish an e-mailing list (such as the Solarmail facility in use by solar physicists) for the space physics community. As an SPDS node, the NSSDC should provide access to orphaned data sets.

(5) Functionality of Directories, Catalogs, and Inventories

As indicated in the critical functionalities section, the role of directories and inventories is to facilitate access to data holdings. Directories should therefore serve as pointers to distributed inventories, in a standard format, that contain sufficient information to characterize the data holding sufficiently to allow the average researcher to decide whether the data are appropriate to the investigation under consideration, and if so, to identify the parts of the data holding that meet his/her particular requirements.

(6) Distribution and Centralization

The Panel felt that a central facility could not only continue to provide the traditional services of Master Directory maintenance and facilities for copying large quantities of data, but could also provide a bulletin board service, gopher, or mail exploder and anonymous FTP server for software and announcements of community interest. All other roles should continue to be performed at the nodes or subnodes, including updates of data inventories, translators for new formats or between platform-specific internal data representations, software development and so on. The Panel endorsed the concept document's emphasis on a distributed system, based on the expertise of the PI group or node-resident, data center scientific staff. Systems capable of accessing data at two or more nodes, and software distributions portable to a variety of end-user platforms, are particularly to be encouraged.

(7) Commonality of Interfaces

The overriding consideration for any SPDS interface should be ease of use by a technically competent investigator. The only critical interoperability requirement is network access, or if necessary, dial-in access to a central facility connected to the Internet.

(8) SPDS as a Technology Clearing House

The SPDS should provide bulletin boards and/or news group(s) for exchanging information on new technology implemented by the node and user community. Such information should be given the widest possible distribution in the community, and communication should be established with communities with similar data technology interests, such as the Planetary and Astrophysics communities.

(9) Support Priorities

The Panel felt that the Space Physics Division should express its support for NASA's efforts to lead in the implementation technologies, such as ATM, that would significantly increase the bandwidth of data communications with currently bandwidth-limited sites. Any effort at accelerating NASA's transfer of this technology to the university community should likewise be supported.

(10) Evaluation of Demonstrated Systems

The Panel commented on the Southwest Research Institute (SwRI) system and found it to have excellent data display and visualization facilities, but its project-spacecraft-instrument-virtual instrument hierarchy can be misleading to inexperienced investigators looking for physical parameters. The multiplicity of IDFS file types necessary for a complete specification of a single data unit was also seen as a drawback for data ported to end-user systems. The IDFS file system is nonetheless a good example of forcing the data provider to make the data self-documenting.

Panel members were impressed with both the DITDOS system’s capabilities for inventorying and browsing data, and the user interfaces developed at the Solar Data Analysis Center (SDAC).

(11) A Suggestion for a Community Survey

As an aid to SPDS nodes developing appropriate software interfaces, the space physics community should be polled, preferably by electronic mail, on such subjects as preferred interface (X-windows, Microsoft Windows, VT terminal emulation, etc.), monitor display capabilities (bit depth, number of pixels, color capability, etc.), data analysis software of choice (Interactive Data Language (IDL), other analysis packages), and available data communications (TCP/IP, DECnet, etc.).

4.4 Software Panel Recommendations

Overview

The Software Panel was to discuss and make recommendations on the software-related aspects of a future SPDS. The main focus of the Software Panel was to define the requirements and priorities for SPDS to support common data analysis and data visualization tools and packages.

There are many existing applications, in both the commercial and public domains, which can be enhanced or extended so that they are compatible. The development of data format translators appears to be the key in creating a confederation of compatible applications and data systems.

Recommendations

The Software Panel made the following recommendations:

(1) That SPDS through NASA funding begin an initiative to develop data format translators that will convert between specific data formats. The specific data formats are listed by the Data Systems Panel. It is believed that any single format can not solve all data analysis and visualization requirements.

(2) That SPDS develop a catalog to provide information to the community about the availability of all useful software that has been developed under NASA funding (hence in the public domain). This catalog should contain information about the programming language, available documentation, relative quality of the code, available support, and on the location of and contact point for the software.

(3) That SPDS should not undertake a new development effort. Rather, NASA should provide funding to extend and enhance existing systems to meet the requirements and needs of an SPDS.

(4) That SPDS encourage and NASA fund the porting of meritorious applications to platforms other than those on which the application was originally developed. The selection of applications should be done by using a peer review process.

(5) That SPDS state as a policy that new application development should meet some minimum standards and that adherence to this policy should become a contractual obligation. It is believed that NASA’s current software development policy imposes too much overhead on software projects. The application development standard should include, but not be limited to, providing a User’s Guide, providing an Installation Guide, coding in a standard language that is supported on multiple platforms, writing portable code (can run on multiple platforms), and internally documenting code with comments preceding each callable component (function, subroutine, etc.) of an application. These comments should include a description of what the components do and the algorithm used. In addition,

arguments, external variables, and any parameters that influence the operation of the component must be identified and described.

(6) That SPDS encourage projects and groups that adopt Commercial Off-The-Shelf (COTS) systems to be sensitive to data portability issues so that data can be used in other systems. Pathways to COTS that are widely used should be provided by NASA, users of the COTS, or suppliers of COTS.

(7) That NASA should assume a capital equipment responsibility and provide funds to insure that the research community have a computing environment which does not act as a limiting factor in general distribution and use, as well as development of software systems.

(8) That SPDS identify as part of a Software Development Policy the platforms and environments on which software should run. The following is recommended:

- The hardware architectures to be supported include: SPARC, VAX, Alpha, Intel x86, Silicon Graphics (SG), Hewlette-Packard (HP), and Macintosh

- The operating systems to be supported include: DOS, SunOS, Solaris, VMS, MacOS, Ultrix, and AIX

- The windowing systems to be supported include: X-windows (X11R5) with Motif and Open Look, MS-Windows, and Mac.

It is acknowledged that above list is valid only at the time of the workshop and will undoubtedly change with time. NASA's policy should reflect this inevitability.

(9) That SPDS select systems that have low maintenance overhead. For example, mail list servers, bulletin board services, usenet news groups and data systems that are configurable and which determine data holdings each time they are run.

Discussion Summary

These recommendations were derived from discussions of a series of questions posed by the SPDS Steering Committee. In some cases, the question required some interpretation in order to focus the discussion of software issues. The following are the questions and a summary of the discussions:

(1a) Should SPDS provide an on-line library of existing software?

A catalog of existing software should be implemented. Providing direct access to a central repository (library) of software is not as important as a catalog since the burden of maintaining current versions may not be cost effective. In addition the expertise on a specific piece of software typically resides with the provider, so software should be obtained from the original developer. Furthermore, applications should be accompanied by a test or an example of data sets so that the user can verify an installation and explore an application's capabilities.

(1b) How should this software be cataloged?

By placing in a queriable system information about the programming language, available documentation, relative quality of the code, available support, and where to obtain the software.

(1c) What software documentation standards should apply?

For applications, a minimal requirement would be to provide a User's Guide and an Installation guide, to code in a standard language that is supported on multiple platforms, to write portable code (can run on multiple platforms), internally document code with comments preceding each callable component (function, subroutine, etc.) of an application. These comments should include a description of the functions of the components and the algorithm used. In addition, arguments, external variables, and any parameters that influence the operation of the component must be identified and described.

(2a) Should SPDS develop new software to support data analysis and/or data visualization?

No. Existing software should be enhanced or extended to meet SPDS needs. Enhancement should include porting of code from one platform to another. If no software currently exists that can meet specific SPDS needs, then development of new software should be funded.

(2b) What software documentation should apply?

See (1c).

(2c) How should this software be distributed?

See (1a).

(2d) What kinds of new software should be developed?

Data format translators to provide bridges between existing data systems and applications including both public domain and major commercial software packages {i.e., Interactive Data Language (IDL) and Advanced Visual System (AVS)}.

(3a) What should the software toolbox contain to support data providers?

Software toolbox should contain data format translators and the software catalog.

(3b) What should the software toolbox contain to support data users?

Software toolbox should contain data format translators and the software catalog.

(4a) What are the desirable aspects of the demonstrated data systems for SPDS to consider?

It was decided that the Panel would not provide an itemized list. All of the systems demonstrated met at least one of the recommendations of the Panel. In addition, this question was more appropriate for the Data System Panel to address.

(4b) What are the undesirable aspects of the demonstrated data systems for SPDS to consider?

It was decided that the panel would not provide an itemized list.

(5a) Should SPDS sponsor development of software tools that could be freely distributed?

SPDS should encourage the sharing of existing software and actively work to make it easier to obtain existing software. No new development initiatives should be undertaken unless there are no existing tools to address the problem. Freely distributed software was considered as a high priority activity.

(5b) Should SPDS define a framework that emphasizes increasing reliance on Commercial Off-The-Shelf (COTS) software?

No, the choice of COTS software should be left up to the individual. However, SPDS should support activities that will provide data format translators that will permit data to be used by COTS. Hopefully, the supplier of the COTS could be encouraged to support data formats identified by SPDS and standard formats. It was also noted that no COTS technology assessment group should be a part of the SPDS.

(5c) Is there a need for SPDS to act as a software clearing house?

A software information clearing house (for COTS and public domain software) that use space physics research community input should be pursued. Actual implementation could be a mail list server, or a moderated or unmoderated bulletin board service. Acting as a software repository is not considered as high a priority as dissemination of information, comments, and experiences.

(6a) Is there a need to define a standard platform or platforms that will be the focus for any SPDS software support? If so, what should they be?

In order to define a standard platform, a stable hardware and operating system market must exist. Since this is a market influenced by communities outside of SPDS, choosing a standard platform does not appear to be viable. However, it is recognized that the current trend is towards UNIX systems that run X-windows on a variety of architectures and Windows-NT running on Intel architectures. The emphasis should be on developing portable code so that it may easily be migrated as new technologies are introduced. A survey of some of the attendees of the workshop indicated that the platforms used by the community are diverse, and changing to a standard platform is not feasible.

(6b) How important as a funding priority should it be to bring access to a standard platform to all active members of the space physics community?

NASA should assume a capital equipment responsibility and provide funds to ensure that the research community have a computing environment that does not act as a limiting factor in the general distribution, uses of software systems. The focus of such funding should be to insure that scientific research is accomplished without incurring additional costs due to redundant software development.

(7a) What should SPDS policy with respect to common formats be?

Specific formats were left to the Data System Panel to define, but the number of formats should be as small as possible.

(7b) What are the technical issues?

There are no technical limitations to providing support for multiple standardized formats. The only limitations are resources. The fewer the formats the smaller the resources needed to provide support for the formats.

Some Efforts Resulting from the Workshop

Some participants at the workshop agreed to explore some of the recommendations of the Software Panel on a volunteer basis. The efforts to be undertaken are:

- Building a Distributed Inventory Tracking and Data Ordering Specification (DITDOS) server to work off the CEDAR inventory and provide a off-line data ordering service.

- Establishing an information server that will contain documentation on data formats which can be publicly accessed.

It should be stressed that all the recommendations of the Software Panel can't be achieved on a volunteer basis. If NASA pursues an SPDS, it should provide sufficient funds to accomplish a fully functional and properly supported SPDS.

5. SUMMARY AND CONCLUSIONS

The panel recommendations were broadly consistent in those areas of joint interest across panel boundaries and reasonably complementary when taken together to define the scope and approach to SPDS. The highest-level observations and recommendations of the SPDS workshop are:

(1) It was agreed that the creation of an SPDS would help fulfill the urgent data exchange requirements presented by upcoming new missions, as well as preserve and improve access to critically important data sets from both past and present programs. It was also agreed that the SPD should initiate the SPDS now, in spite of very limited funding. As the scientific productivity of SPDS is demonstrated and recognized by a broader scientific community, it was strongly recommended that NASA will need and ought to provide significant new resources to the Division to support SPDS. It was suggested that follow-on users community workshop should be held in a year or so.

(2) The five functional objectives identified in the SPDS Concept Document are appropriate. The most important SPDS objective should be to provide the scientific research community with access to high quality data products. Support for the dissemination of data analysis tools is important but of secondary priority. Awareness of recent development in data management technologies is important for SPDS but is the lowest of the five functional objectives.

(3) The workshop endorsed the Concept Document's emphasis on a distributed data system designed, developed, and operated by scientific users of space physics data. The SPDS should make maximum use of existing facilities including data centers, project data management units, individual centers at Principal Investigator (PI) institutions, and existing computer networks. The current paradigm envisions use of the NASA Master Directory to indicate what data are available and where, the use of existing software and human systems to retrieve data, and the uses of data format translators to import data into an investigator's own analysis system. Funding should be awarded competitively through peer review. In the initial stage, this could be through an augmentation or supplement to scientific investigations selected under existing peer review programs.

(4) Consistent with a philosophy of a grass-roots effort built from existing capabilities and operating as a community-distributed service, SPDS should emphasize the concept of “coordination” and “coordinators” as a management approach to accomplishing its larger goals. Formal SPDS management authority should remain with MO&DA Program of the Division. Initially, there should be Project Coordinator(s) and Discipline Coordinator(s) representing each of the four Space Physics Division branch-discipline user communities. The Discipline Coordinators should be scientists within their community who presently work with, and exchange, data. The Project Coordinator(s) will provide contact between the SPDS and other NASA's data system activities, with other government agencies and the international community as well as work with the Discipline Coordinators.

(5) Participation in SPDS by all current and future division-related investigations, and their Principal Investigators (PIs) during the active phase of missions, should be facilitated. This will require recognition of and adequate safeguards for the protection of data so long as they remain proprietary.

(6) In addition to the above broad principles and recommendations, numerous specific observations and recommendations were made by the individual panels within their specific areas and are contained in detail in the body of this report.

Since the workshop and in direct response to its recommendations, the Space Physics Division has called for volunteers and now has named an "SPDS Coordinators" Working Group (SPDS/CWG) that will be composed of:

- an SPDS Project Scientist,
- four SPDS Lead Discipline Coordinators, and
- two SPDS Project Co-Coordinator(s).

The Lead Discipline Coordinators will be supported by four Discipline Coordination Teams from volunteers in their communities whose concerns and perspectives are then in turn to be represented by the respective Lead Discipline Coordinator. The initial designees and their addresses etc. are shown in Appendix E. The SPDS/CWG has the broad responsibility to move the definition of an SPDS program forward from the Concept Document and the recommendations of the workshop, to start a first working version of SPDS and to serve as focal points for advertising SPDS, compiling and disseminating information about available data and data access, and establishing a beginning set of "rules of the road" for data exchange and SPDS participation.

The role of the Space Physics Division will be to stimulate and catalyze the grass roots development of the Space Physics Data System. The Space Physics Division will provide limited amounts of funding to enable the Discipline Coordinators, Project Coordinator (s), and the Science Advisory Team to carry out their functions. It is the intention that when more significant added funding for SPDS becomes possible, those funds will be allocated through a competitive process as recommended in the SPDS Concept Document and endorsed at the community SPDS workshop. The Space Physics Division MO&DA Coordinator will be the primary point of contact at Headquarters for this effort.

The prototype/demonstration SPDS services collaboration remains operational and accessible in a common manner through the NASA Master Directory with information about SPDS, its status and other prototype work also accessible as an option of NSSDC "NODIS" guest account. The workshop participants in the data systems panel also defined an experiment they would undertake to see whether DITDOS, an inventory tracking system developed by PDS, could be used easily and inexpensively to manage existing space physics inventories. The CEDAR project inventory established at NCAR was selected as a test case. The Institute of Geophysics and Planetary Physics (IGPP) at UCLA has established a list server to serve the SPDS community as a forum for discussing SPDS related issues. To be on the mailing list, please send an e-mail to LISTSERV@IGPP.UCLA.EDU, with the message "SUBSCRIBE SPDS {FULL_NAME}"; where {FULL_NAME} is your first and last name.

REFERENCES

(1) Data Management and Computation, Volume 1: Issues and Recommendations, Committee on Data Management and Computation, Space Science Board, National Academy Press, 1982, pages 43–47.

(2) Issues and Recommendations Associated with Distributed Computation and Data Management Systems for the Space Sciences, Committee on Data Management and Computation, Space Science Board, National Academy Press, 1986, pages 87.

(3) NASA is Not Archiving All Potentially Valuable Data, GAO/IMTEC-91-3, November 1990.

(4) NASA is Not Properly Safeguarding Valuable Data from Past Missions, GAO/IMTEC-90-3, March 1990.

(5) State of the Data Union, NASA Office of Space Science and Applications, 1992.

(6) Concept Document on NASA's Space Physics Data System, prepared by SPDS Steering Committee, February 1993.

(7) National Collaboratories: Applying Information Technology for Scientific Research, National Research Council, National Academy Press, 1993.

LIST OF ACRONYMS

ADS	Astrophysics Data System
AE	Atmosphere Explorer
AGU	American Geophysical Union
AO	Announcement of Opportunity
ARMS	Automated Retrieval Mail System
ASCII	American Standard Code for Information Interchange
AVS	Advanced Visual System
CEDAR	Coupling Energetics and Dynamics of Atmospheric Regions
CDAW	Coordinated Data Analysis Workshop
CDF	Common Data Format
CD-ROM	Compact Disk-Read Only Memory
CGRO	Compton Gamma Ray Observatory
C&H	Cosmic and Heliospheric
CMIT	CDF Macintosh Imaging Tool
CODMAC	Committee on Data Management and Computation
Co-I	Co-Investigator
COHO	Coordinated Heliospheric Observations
COTS	Commercial Of The Shelf
CXIT	CDF X-Window Imaging Tool
DC	Discipline Coordinator
DCT	Discipline Coordinator Team
DE	Dynamics Explorer
DECnet	Digital Equipment Corporation Network
DITDOS	Distributed Inventory Tracking and Data ordering Specification
DoD	Department of Defense
DoE	Department of Energy
DOS	Disk Operating System
ESA	European Space Agency
FITS	Flexible Image Transport System
FTP	File Transfer Protocol
GGS	Global Geospace Science
GI	Guest Investigator
GOES	Geostationery Orbiting Environmental Satellite
GONG	Global Oscillation Network Group
GRO	Gamma Ray Observatory
GRS	Gamma Ray Spectrometer
GSFC	Goddard Space Flight Center
GUI	Graphical User Interface
HAO	High Altitude Observatory
HDF	Hierarchical Data Format
HP	Hewlette-Packard
HRTS	High Resolution Telescope and Spectrograph
IDFS	Instrument Data File Set
IDL	Interactive Data Language
IGPP	Institute of Geophysics and Planetary Physics
IMF	Interplanetary Magnetic Field
IMP	Interplanetary Monitoring Platform
ISTP	International Solar-Terrestrial Physics
LPARL	Lockheed Palo Alto Research Laboratories
MIT	Massachusetts Institute of Technology
MO&DA	Mission Operations and Data Analysis
NASA	National Aeronautics and Space Administration

NCAR	National Center for Atmospheric Research
NDADS	NASA/NSSDC Data Archive and Distribution System
NIST	National Institute of Standards and Technology
NMD	NASA Master Directory
NODIS	NSSDC Online Data and Information Service
NRA	NASA Research Announcements
NSF	National Science Foundation
NSFnet	National Science Foundation Network
NSI	NASA Science Internet
NSN	NASA Science Network
NSO	National Solar Observatory
NSSDC	National Space Science Data Center
OMNI	Interplanetary Medium Data
PC	Project Coordinator
PDS	Planetary Data System
PI	Principal Investigator
PPI	Planetary Plasma Interaction node of PDS
SAT	Science Advisory Team
S/C	Spacecraft
SCATHA	Spacecraft Charging AT High Altitudes
SDAC	Solar Data Analysis Center
SGI	Silicon Graphic Interface
SMM	Solar Maximum Mission
SMTP	Simple Mail Transfer Protocol
SPAN	Space Physics Analysis Network
SPD	Space Physics Division
SPDF	Space Physics Data Facility
SPDS	Space Physics Data System
SPDS/SC	SPDS Steering Committee
SSC	Satellite Situation Center
SSE	Solar System Exploration Division
SwRI	Southwest Research Institute
TCP/IP	Transmission Communication Protocol/Internet Protocol
TENNIS	A format adopted for SAMPEX data
UARC	Upper Atmospheric Research Collaboratory
UARS	Upper Atmospheric Research Satellite
UCLA	University of California, Los Angeles
UNH	University of New Hampshire
US	United States of America
WAIS	Wide Area Information Server
Yohkoh	Japanese Solar Physics Mission

Appendix A

Agenda

Agenda for the Community-Wide Workshop on NASA's Space Physics Data System, June 1-3, 1993, Rice University, Houston.

Tuesday, June 1, 1993

7:45 am	Registration and Coffee

Plenary Session # 1

8:15 am	Welcoming Remarks Patricia Reiff, Rice University, Houston
8:30 am	Introduction Ray Walker, University of California, Los Angeles
8:40 am	Discipline Data Systems: What Has Been Done and What We Have Learned? Joe King, National Space Science Data Center/Goddard Space Flight Center
9:40 am	The Overview of SPDS Concept Document Ray Walker, University of California, Los Angeles
10:25 am	Break
10:40 am	The Charge of SPDS and the Workshop Jim Willett, NASA Headquarters, Space Physics Division Ray Walker, University of California, Los Angeles
11:00 am	The Reports from the Chairs of Space Physics Disciplines Data Evaluation Panels (10 minutes for each Discipline)
11:30 am	The Overview of the Demonstrations; What Has Been Done? David Winningham, Southwest Research Institute, San Antonio
Noon	Lunch
1:00 pm	Demonstrations of Pre-SPDS Capabilities Existing in the Space Physics Community
2:30 pm	Break
3:15 pm	Parallel Meetings of Workshop Panels. The demonstrations will remain available during the meetings of panels. Each panel Chair will arrange for additional viewing time.

Plenary Session # 2

5:15 pm	Brief Reports from Chairs of Workshop Panels (15 minutes for each panel, Room 124).
6:15 pm	Adjourn for the Day

Agenda (Continued)

Wednesday, June 2, 1993

7:45 am	Registration and Coffee
8:15 am	Parallel Meetings of Workshop Panels. A Chance for Visiting other Panels.
10:00 am	Break

Plenary Session # 3

10:15 am	Preliminary Reports of the Meetings of Workshop Panels: What is Decided? What is not Decided? Panel Chairs (Approximately 20 Minutes for each Panel).
Noon	Lunch
1:00 pm	Demonstrations Continues, Workshop Panels Start Writing Reports, and Poster Presentations will Start.
3:00 pm	Break
3:15 pm	Demonstrations Continues, Workshop Panels Continue Writing Reports, and Poster Presentation will Continue.
6:15 pm	Adjourn for the Day

Thursday, June 3, 1993

7:45 am	Coffee

Plenary Session # 4

8:15 am	Final Reports of the Workshop Panels Meetings: What is Decided? What is not Decided? Panel Chairs (30 minutes for each Panel).
10:15 am	Break
10:30 am	Rewriting of Final Reports of the Meetings of Workshop Panels.
Noon	General Meeting Adjourned
1:00 pm	Meeting of the SPDS Steering Committee and Chairs of four Workshop Panels.
3:30 pm	Meeting Adjourned

Appendix B

Official Workshop Attendees

Community-wide Workshop on NASA's Space Physics Data System
Rice University, Houston, Texas
June 1-3, 1993

Attendees List

Name	Affiliation
Adams, Lee Ann	Science Applications International Corporation
Aist-Sagara, Lara	Hughes STX
Anderson, David	Southwest Research Institute
August, A. David	Southwest Research Institute
Bering, Edgar	University of Houston
Bilitza, Dieter	Hughes STX
Birkelbach, Karen	Southwest Research Institute
Blackowiak, Kara	Southwest Research Institute
Bogart, Richard S.	Stanford University
Borgen, Rosana	Jet Propulsion Laboratory
Burns, Alan G.	University of Michigan
Candey, Robert	NASA/Goddard Space Flight Center
Chan, Anthony	Rice University
Cook, John W.	Naval Research Laboratory
Costello, Kirt	Rice University
Emery-Geiger, Barbara	HAO/National Center for Atmospheric Research
Franzgrote, Ernest	Jet Propulsion Laboratory
Fried, Eva	University of California, Los Angeles
Gallagher, Maria	NASA/Ames Research Center
Garrard, Tom	California Institute of Technology
Gonzalez, Carrie	Southwest Research Institute
Groene, Joe	University of Iowa
Gurgiolo, Chris	Southwest Research Institute
Gurman, Joseph	NASA/Goddard Space Flight Center
Guzik, Greg	University of Iowa
Hernandez, Jose	University of Texas at Austin
Hess, Susan M.	Jet Propulsion Laboratory
Hill, Frank	National Solar Observatory
Horton, Wendell	University of Texas at Austin
Huang, Cheryl Y.	University of Iowa
Umran, Inan	Stanford University
Johnson, Judith	NASA/Goddard Space Flight Center
King, Joe	NASA/Goddard Space Flight Center
King, Todd	University of California, Los Angeles
Klumpar, David M.	Lockheed Palo Alto Research Laboratories
Kramer, Leonard	Rice University
Krone, Jim	Los Alamos National Laboratory
Kurth, Bill	University of Iowa
Lal, Nand	NASA/Goddard Space Flight Center
Le, Guan	University of California, Los Angeles
Levenson, Ken	University of New Hampshire
Lozano, Albert	Southwest Research Institute
McEntire, Richard	APL/Johns Hopkins University

Community-wide Workshop on NASA's Space Physics Data System
Rice University, Houston, Texas
June 1-3, 1993

Attendees List (Continued)

Name	Affiliation
McPherron, Robert	University of California, Los Angeles
Miah, M.A.	University of Arkansas at Pine Bluff
Miller, David	Southwest Research Institute
Moore, Kurt	Los Alamos National Laboratory
Murphy, Richard	Southwest Research Institute
Nguyen, Sandy	Southwest Research Institute
Nylund, Stuart	APL/Johns Hopkins University
Petit, Noel	Augsburg College
Post, Carla	Science Applications International Corporation
Pyle, K. Roger	University of Chicago
Rasmussen, Craig	University of Michigan
Reeves, Geoffrey	Los Alamos National Laboratory
Reiff, Pat	Rice University
Richards, Phil	The University of Alabama in Huntsville
Richardson, John	Massachusetts Institute of Technology
Russell, Christopher T.	University of California, Los Angeles
Sharma, Rikhi	Science Applications International Corporation
Shine, Richard	Lockheed Palo Alto Research Laboratories
Sibeck, David	APL/Johns Hopkins University
Spence, Harlan E.	The Aerospace Corporation
Strangeway, Bob	University of California, Los Angeles
Toy, Neil	Jet Propulsion Laboratory
Trueblood, Mark	National Solar Observatory
Walker, Ray	University of California, Los Angeles
Weiss, Loretta	Rice University
Weymouth, Terry	University of Michigan
Willett, Jim	NASA Headquarters
Winningham, J. David	Southwest Research Institute
Wuest, Martin	Southwest Research Institute
Zarro, Dominic	Applied Research Corporation/GSFC
Zwickl, Ron	NOAA/Space Environmental Laboratory

Appendix C

Abstracts for Demonstrations and Poster Presentations

Abstracts for Demonstration and Poster Presentations

1) High Information Content Photographic Data from Solar Physics Experiments, J. W. Cook, Naval Research Laboratory.

2) The Data Access System of the Planetary Data System's Planetary Plasma Interactions Node, Todd King, Steven P. Joy, Raymond J. Walker, and Eva Fried, University of California, Los Angeles.

3) Data Access and Analysis Tools at The University of Iowa, W. S. Kurth, University of Iowa.

4) UCLA Space Physics Interactive Graphics Analysis Software, C. T. Russell, J. G. Luhmann, G. Le, P. Song and Q. Chen, University of California, Los Angeles.

5) UCLA Space Physics Educational Software, C. T. Russell, J. G. Luhmann, G. Le, M. H. Farris and B. Littlefield, University of California, Los Angeles.

6) A Graphical User Interface for Solar Data Analysis, D. Zarro (Applied Research Corporation), E. Einfalt (Hughes/STX), A. Tolbert (Hughes/STX), J. Gurman (NASA/GSFC), R. Schwartz (Hughes/STX), and R. Nakatsuka (Hughes/STX).

7) Analysis support package for AE and DE data, A. G. Burns and T. L. Killeen, University of Michigan.

8) Online Space Physics Systems and Services of SPDF/NSSDC Robert E. McGuire, Robert M. Candey, and Joseph H. King, NASA GSFC.

9) Access to LPARL Solar Data Holdings, Richard Shine and Samuel L. Freeland, Lockheed Palo Alto Research Laboratories.

10) Solar Physics Data Archives at the National Solar Observatory, Frank Hill, National Solar Observatory.

11) Geophysical Data Analysis Using Nonlinear Feed Forward Perceptions: Forecasting Geomagnetic Activity, J.V. Hernandez, W. Horton, and T. Tajima, University of Texas at Austin.

12) Wideband Plasma Wave Data Analysis and Archiving, Vikas S. Sonwalkar and Umran S. Inan, Stanford University.

13) A Portable Non-Intrusive Data Inventory Tracking and Access System, Todd King, Steven P. Joy, and Raymond J. Walker, University of California, Los Angeles.

14) The Atomic Branching Ratio Project at NIST, J. Z. Klose and W. L. Wiese, National Institute of Standards and Technology.

15) The SMM Database of High Energy Gamma Ray Transients, Ken Levenson, University of New Hampshire.

16) Solar Wind Archives at M.I.T., J. D. Richardson, J. W. Belcher, and A. J. Lazarus, Massachusetts Institute of Technology.

17) Opal Atomic, Equation of State, and Opacity Data, Forrest Rogers and Carlos Iglesias, Lawrence Livermore National Laboratory Livermore.

18) The SCATHA Experiment: A Valuable Space Physics Data Set Ripe for Salvage, Harlan E. Spence and Joseph F. Fennell, The Aerospace Corporation.

19) Application of a Neural Network for Background Estimation in a 10 Year X-Ray Data Set, D. J. Forrest, University of New Hampshire.

20) The CEDAR Data Base, B. Emery, R. Barnes, and A. Richmond, High Altitude Observatory/National Center for Atmospheric Research, Boulder.

21) Rescue and Restoration of Existing Useful Space Physics Data Sets: Magnetospheric Physics, Hunter Waite et al., Southwest Research Institute, San Antonio, Texas.

22) Upper Atmospheric Research Collaboratory (UARC) Project, Terry E. Weymouth, University of Michigan, Ann Arbor.

23) The Southwest Data Display and Analysis System: A Tool for Space Physics, R. Murphy, Southwest Research Institute.

1) High Information Content Photographic Data from Solar Physics Experiments

J. W. Cook, E. O. Hulburt Center for Space Research, Naval Research Laboratory

Rocket and space shuttle experiments in the solar physics discipline supported by NASA still often make use of photographic recording. A list of a number of such recent experiments will be given and the potential information content from the High Resolution Telescope and Spectrograph (HRTS) instrument will be analyzed. This instrument is developed at the Naval Research Laboratory. HRTS has so far flown 8 times as a sounding rocket payload, and once on the Spacelab 2 shuttle mission.

HRTS can cover the wavelength range 1175–1710 Å with 0.05 Å spectral resolution, and observes with a 920 arc sec length slit with approximately 1 arc sec spatial resolution. If a photographic spectrum is sampled at only 2 pixels per linear resolution element (slightly less than optimal), with 2 bytes per pixel, a single HRTS spectrum results in approximately 80 Mbytes of data. A typical sounding rocket flight can obtain 30 or more such exposures. Special problems with such data for inclusion in a Space Physics Data System will be discussed.

A demonstration of an existing data analysis system for HRTS spectra will be given if an appropriate networked computer terminal is available.

2) The Data Access System of the Planetary Data System's Planetary Plasma Interactions Node

Todd King, Steven P. Joy, Raymond J. Walker, and Eva Fried, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024-1567

The Planetary Data System's Planetary Plasma Interactions (PDS/PPI) Node publishes fields and particles data from NASA's planetary missions on a variety of media including CD-ROM. In addition the Node has a network accessible data access user interface which allows a user to select, visualize, and order on-line data. It also supports requesting that off-line data be brought on-line. Since off-line data requests are message based, it is possible that the operation of bringing off-line data sets on-line can be automated.

The PDS/PPI data access interface is a client/server application based on the DITDOS protocol. Data in the PPS/PPI system are stored on a variety of media which includes hard disks and CD-ROMs. All data are stored in the format specified by the project for each spacecraft and instrument. When agreed upon common data formats are used. As a rule data is not reformatted into a canonical format. Currently data is arranged as files in a hierarchical set of directories. DITDOS inventory information is built for each data set collection and is placed in each CD-ROM containing the data. The server uses the DITDOS inventories to provide information to the client application.

The user interface for the system is a menu based graphical user interface. Data is selected by first choosing a database, then choosing a data set. After this individual member files can be selected. All of the data related menus are defined at run-time. The contents of each menu is determined by querying the server for a list of its current data holdings. The user interface library used in building the interface has the potential to support multiple look and feels. Ultimately the interface will support the VT100 and Motif look and feels.

3) Data Access and Analysis Tools at The University of Iowa

W. S. Kurth, Department of Physics and Astronomy, University of Iowa, Iowa City, IA 52242

The University of Iowa has been quite active recently in the restoration and curation of data of interest to the space physics community. The most firmly established effort is the Planetary Data System activity as a result of our subnode relationship with the Planetary Plasma Interactions node at UCLA. Data held for this activity includes plasma wave data for all of the Voyager encounters, access to planetary radio astronomy data from Voyager, future acquisitions of Pioneer Geiger Tube Telescope data from Jupiter and Saturn, and Galileo plasma wave and plasma data from Venus, Earth, asteroids, and Jupiter. More recently, the University of Iowa has been an active participant in the development of a concept for the Space Physics Data System and has been actively archiving wideband plasma wave data from a number of Earth-orbiting spacecraft.

The demonstrations to be presented at this workshop are designed to emphasize the type of tools which are available to investigators who wish detailed access to and specific analyses of plasma wave data; broad, correlative access to data from multiple instruments of varying nature is not the goal of these tools but are a complementary aspect of a robust data system. One system which will be presented is an analysis package written for a personal computer which provides access to the full resolution plasma wave observations from Voyager that are currently being archived on CD-ROM. This package allows the spectrum analyzer data to be displayed as a stacked set of one or more of the 16 frequency channels at virtually limitless temporal resolutions (within the capabilities of the instrument). Another option converts the multichannel display into a color or black-and-white frequency-time dynamic spectrogram. A third option allows the user to produce amplitude versus frequency spectra averaged over a specified interval of time. These options comprise the basic set of analysis tools used for the vast majority of Voyager plasma wave studies. A second tool to be demonstrated also runs on a personal computer and provides access to high spectral and temporal resolution wideband data from Earth-orbiting plasma wave instruments as well as those from Voyager. A UNIX version of this package is also being developed for users with requirements for greater throughput and flexibility. Finally, we can also demonstrate the use of a client-server system which connects the University of Iowa with the Browse System at UCLA. This system makes virtually the full range of fields and particles data held by the Planetary Data System available in browse form to the user who is in search of data required for either a specific or general program of research.

4) UCLA Space Physics Interactive Graphics Analysis Software

C. T. Russell, J. G. Luhmann, G. Le, P. Song, and Q. Chen, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024-1567

As part of its efforts in the scientific analysis of the observations returned by the ISEE 1 and 2 and Pioneer Venus missions, the UCLA Space Physics Group has developed a series of interactive graphics analysis routines for the study of space physics data, especially for the analysis of magnetic fields. These tools include techniques for the visualization of the measurements as well as time series analysis techniques. These programs have been recently converted to run on UNIX workstations in an X-Windows environment and have been programmed in the C-language. We will demonstrate these modules for the participants in the workshop.

5) UCLA Space Physics Educational Software

C. T. Russell, J. G. Luhmann, G. Le, M. H. Farris, and B. Littlefield, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024.

In support of its introductory courses in space physics, both at the upper division and graduate student levels, the UCLA Space Physics Group has developed a series of computer based, interactive graphics exercises covering planetary magnetic fields, single particle motion in electric and magnetic fields, cold plasma waves and collisionless shocks. These modules run on UNIX workstations in an X-Windows environment and have been programmed in the C-language. We will demonstrate those modules for the participants of the workshop.

6) A Graphical User Interface for Solar Data Analysis

D. Zarro (Applied Research Corporation), E. Einfalt (Hughes/STX), A. Tolbert (Hughes/STX), J. Gurman (NASA/GSFC), R. Schwartz (Hughes/STX), and R. Nakatsuka (Hughes/STX)

We will demonstrate a Graphical User Interface (GUI) that we have designed for the inspection and analysis of space-based solar observations. The GUI was developed at the Solar Data Analysis Center (SDAC) at Goddard Space Flight Center (GSFC), using the Interactive Data Language (IDL) widget toolkit. The GUI provides a set of menu-driven interfaces that facilitate the reduction and analysis of solar data recorded by instruments on board the Solar Maximum Mission (SMM) satellite (1980-1989), the GOES satellite, as well as ground-based observations.

The SMM spacecraft was composed of several complex instruments that observed solar activity at optical and ultraviolet wavelengths, and at x-ray and gamma-ray energies. These instruments produced a wealth of images, spectra, and light curves of solar flares and active regions. The GUI provides a convenient tool for browsing and selecting from these data sets. In particular, the GUI offers a menu-driven system to process and display these data in a variety of forms including movies, spectral histograms, time profiles, and intensity scans. Without detailed knowledge of a particular instrument, a user can easily choose data subsets and different plot options using a simple set of buttons, sliders, and list menus whose functions are intuitively obvious.

We will demonstrate the GUI in automatic and interactive modes. The automatic mode will cycle though a series of sample menus that illustrate many of the GUI features and capabilities. In interactive mode, the user will be able to select and examine a variety of available data sets. The GUI has the additional capability that it can be operated over a computer network (currently over DECnet) to allow remote access to the SDAC data holdings. At present, the GUI operates primarily on a VMS platform. We are in the process of porting the GUI software to a UNIX system, and are planning to incorporate additional solar data sets from the Japanese Yohkoh mission and the GRO/Compton Gamma-Ray Observatory.

7) Analysis support package for AE and DE data

A. G. Burns and T. L. Killeen, Space Physics Research Laboratory, Department of Atmospheric, Oceanic and Space Science, University of Michigan, Ann Arbor, MI 48109.

The Space Physics Research Laboratory at the University of Michigan has participated in many NASA aeronomy missions and has access to a large data base from Atmosphere Explorer (AE), Dynamics Explorer (DE), and UARS. In particular, data from instruments devoted to optical remote sensing of upper atmospheric parameters have provided a fertile resource for scientific research over extended time periods (> 10 years). In this poster we demonstrate the menu driven user-friendly software system developed as an aid in the multi-instrument graphical analysis of AE and DE data. The system is available to NASA internet users. Plans are currently being developed to augment this capability.

8) Online Space Physics Systems and Services of SPDF/NSSDC

Robert E. McGuire, Robert M. Candey, Space Physics Data Facility (SPDF), Code 632, NASA/GSFC, Greenbelt, MD 20771

Joseph H. King, National Space Science Data Center (NSSDC), Code 633, NASA/GSFC, Greenbelt, MD 20771

A variety of data and information services particularly relevant to researchers in the space physics sciences community are available online in the NSSDC Online Data and Information Services (NODIS) account. Newly revised, NODIS now provides a single access point to a wide range of services and has been extended to provide a single common point of access to the Coordinated Data Analysis Workshop (CDAW) system and the science planning capabilities of the Satellite Situation Center (SSC) software. CDAW and SSC are operated jointly by SPDF and NSSDC.

Systems to be specifically demonstrated at this workshop include:

NASA Master Directory (NMD): A multidisciplinary directory of space and earth science data sets, including high-level descriptions and mechanisms for searching by important criteria such as geophysical parameters, time and spatial coverage, data system etc. NMD now includes entries and links to the systems participating in the demonstration of pre-space physics data system effort.

Coordinated Data Analysis Workshop (CDAW): Data display and analysis with available multi-spacecraft and multi-instrument databases including CDAW-6/7 (4 events in March-April 1979 and May 1980); CDAW-8 (8 events in January-April 1983); and CDAW-9 (to be publically available shortly, 5 events in April-May 1986).

Satellite Situation Center (SSC): Spacecraft orbit displays and listing in multiple coordinate systems with both definitive and predictive orbits for important present and future spacecraft; ability to identify spacecraft-spacecraft and spacecraft-ground field-line conjunctions and times of magnetospheric region occupancy and co-occupancies.

Interplanetary Medium Data (OMNI): Access to hourly averaged near-Earth solar wind magnetic field, plasma and energetic particle data and some solar/geomagnetic indices, from 1973 to (typically) about 1 year from present.

Geophysical Models: Ability to download code, coefficients, or model calculation results for geomagnetic fields (IGRF 1991, with models such as Tsyganenko 1987 also available for distribution), energetic trapped protons and electrons (AP-8, AE-8), the ionosphere (IRI-1990) and the neutral atmosphere (MSIS-86).

Access to data assets held nearline in the NASA/NSSDC Data Archive and Distribution System (NDADS) optical jukeboxes via electronic mail-based ordering and electronic data delivery by file transfers (Automated Retrieval Mail System or ARMS) will be shown. Present NDADS holdings of space physics interest include IMP-8 15-second magnetometer data, DE-1 spin-scan auroral images, DE-2 vector electric fields, and Sky lab digitized X-ray images and continue to grow. Online NSSDC space physics data (access via DECnet copy or anonymous FTP) additionally include the COHO (Coordinated Heliospheric Observations) database of deep-space heliospheric field, plasma, and cosmic ray data.

Several display programs keyed to data cast in the NSSDC-developed Common Data Format (CDF) will also be demonstrated. The "ISTP Key Parameter Visualization Tool" displays the key parameters using IDL with widgets. It is a generic software package for all missions in ISTP program. The CDF X-window Image Tool (CXIT) and CDF Macintosh Image Tool (CMIT, in progress) display CDF-formatted images (e.g. from the DE-1 SAI images instrument) mapped to the Earth using various transforms.

9) Access to LPARL Solar Data Holdings

Richard A. Shine and Samuel L. Freeland, Lockheed Palo Alto Research Laboratories

Several solar physics research efforts at Lockheed Palo Alto Research Laboratories (LPARL) are producing enormous amounts of data, primarily in the form of digital images. Access and tools for two major categories will be demonstrated. The first is data from the Yohkoh satellite and related space (e.g., GOES and BATSE) and groundbase (e.g., KPNO, VLA, and BBSO) data. Remote access to catalogues and data will be demonstrated and (dependent on all equipment operating) near real time x-ray images of the sun taken by SXT instrument will be shown.

The other category consists of ground based solar movies taken over the last 6 years using proto-type equipment developed for the Orbiting Solar Observatory. These include high resolution magnetograms, dopplergrams, continuum, and H alpha movies of solar activity. Approximately a terabyte of raw data is stored on 8 mm Exabyte tapes. In order to allow rapid browsing through this data and the viewing of the image sequences as movies, we have recorded most of it on analog video disk. This equipment will be demonstrated as well as access and analysis tools for the digital data set.

10) Solar Physics Data Archives at the National Solar Observatory

Frank Hill, National Solar Observatory, Tucson, AZ

The National Solar Observatory (NSO) comprises two sites at Sacramento Peak, Sunspot, NM, and at Kitt Peak, Tucson, AZ. These two sites produce several solar physics data sets, both synoptic and campaign, that are being archived and are of interest to users of the NASA SPDS. These data sets include the daily Kitt Peak magnetograms (originally obtained in support of the NASA Sky lab mission), Kitt Peak 10830 images, Sac Peak coronal maps, and Sac Peak H-alpha images. In addition to these long-term archives, NSO is the headquarters for the Global Oscillation Network Group (GONG) Project. This project will produce approximately 4 Terabytes of data in the form of nearly continuous velocity, intensity, and modulation images, as well as power spectra of the solar oscillations. New instruments, such as the High-Degree Helioseismograph, the Advanced Stokes Polarimeter, and the RISE instrument, are also beginning to provide large amounts of high-quality solar physics data at NSO. The NSO data sets could be usefully incorporated into the NASA SPDS.

11) Geophysical Data Analysis Using Nonlinear Feed Forward Perceptions: Forecasting Geomagnetic Activity

J.V. Hernandez, W. Horton, and T. Tajima, Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712

An important problem from both the applied and conceptual points of view is that of forecasting geomagnetic activity represented by indices such as AL, AE, etc., from satellite-based measurements of solar wind and interplanetary magnetic field (IMF) data and from past ground-based measurements of geomagnetic activity. Linear correlative studies[1] and linear filtering techniques[2] have shown, among other things, that the magnetosphere is a complex nonlinear dynamical system and thus, that the magnetosphere should be modeled from a nonlinear point of view using, for example, nonlinear analog models of geomagnetic activity[3]. We address the forecasting of geomagnetic activity issue from a nonlinear filtering point of view using simple feed forward perceptions or neural networks. We find that about 90% of the AL index variance of the Bargatze et al.[2] data base can be accounted for by our nonlinear neural net-based filter. Furthermore, our results give strong support to the idea that even though the magnetosphere is randomly driven by the solar wind input, the magnetosphere constitutes a low-dimensional[4-5] deterministic system.

References

1. Baker, D.N., E.W. Hones, Jr., J.B. Payne, and W.C. Feldman, Geophys. Res. Let. 8, 179 (1981).
2. Bargatze, L.F., D.N. Baker, R.L. McPherron, and E.W. Hones, Jr., J. Geophys. Res. 90, 6387 (1985).
3. Klimas, A.J., D.N. Baker, D.A. Roberts, D.H. Fairfield, and J. Buchner, J. Geophys Res. 97 12,253 (1992).
4. Roberts, D.A., D.N. Baker, and A.J. Klimas, Geophys. Res. Let. 18, 151 (1991).
5. Sharma, A.S., D. Vassiliadis, and K. Papadopoulos, Geophys. Res. Let. 20, 335 (1993).

12) Wideband Plasma Wave Data Analysis and Archiving

Vikas S. Sonwalkar and Umran S. Inan, STAR Laboratory, Stanford University, Stanford, CA 94305

In this paper we describe the wideband plasma wave data archiving and analysis system developed at Stanford. The Macintosh based system performs digitizing, time decoding, and storage of wideband data in a standard format on 8 mm Exabyte tapes. The standard format, similar to one used in Planetary Data System (PDS), was developed in collaboration with U. of Iowa. The standard format allows data to be easily transported to various other machines including IBM-PC and UNIX based work stations. At the time of analysis, the stored data can be easily read as a time decoded time series with or without re-sampling performed. Re-sampling which corrects for tape flutter in the original analog data is needed for high time resolution analysis and for comparison with other data sets. The primary data set to be archived is from the wideband linear wave receiver (LWR) on the DE

1 satellite. Approximately 2 Tera Bytes of wideband analog data has been collected over ~10 year lifetime of the DE 1 mission. Unique features of LWR allow for measurement of absolute electric and magnetic field strengths in the VLF range of both signals of natural origin, such as hiss and chorus, and ground transmitter signals and associated wave -particle interaction phenomena, such as triggered emissions and generation of lower hybrid waves. Spin fading and near simultaneous measurements of electric and magnetic fields allow for determination of wave polarization and wave normal vector in three dimensions of ground transmitter and natural signals. Digital analysis also lends itself to the extraction of weak signals above noise and to determination of spin characteristics of randomly occurring discrete chorus elements. Results from the digital analysis of LWR wave data from the DE 1 satellite illustrating the power and the usefulness of the system are presented. We discuss the applicability of the analysis concepts and the digital system described here to plasma wave data from future space missions including ISTP.

13) A Portable Non-Intrusive Data Inventory Tracking and Access System

Todd King, Steven P. Joy, and Raymond J. Walker, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024-1567

At UCLA we have designed a data system which provides an interface for accessing data which is stored in any format. In addition the data can reside on any media, including the network, CD-ROM and hard disks. Data that exists in other data systems can also be accessed by this system. We call this system a Distributed Inventory Tracking and Data Ordering System (DITDOS).

With DITDOS an inventory of all data holdings is built. This is typically accomplished in an automated fashion by scanning existing data collections. The DITDOS inventory information was designed to provide the minimum amount of information required to track and order data. Entries in a DITDOS inventory are grouped into data sets and each member of a data set is a physical collection of data. Every data collection is associated with a class and instance. The class and instance of a member determines which specialized readers, viewers and writers are used for accessing, ordering and visualizing the data.

There is also a DITDOS protocol for client and servers to exchange information. The protocol is tailored for inventory and data ordering communications. With the DITDOS protocol servers can be constructed to interface to existing data systems. Since DITDOS is non-intrusive, there is no need for the duplication or reformatting of data. Thus both DITDOS and specialized data access methods can co-exist. The protocol also has support for requesting that off-line data sets be brought on-line and for sending messages to the administrator of the data system.

DITDOS inventories and the DITDOS protocol has been adopted by the Planetary Data System's Planetary Plasma Interactions Node (PDS/PPI). DITDOS inventories are also placed on all CD-ROMs the Node generates.

14) The Atomic Branching Ratio Project at NIST

J. Z. Klose and W. L. Wiese, National Institute of Standards and Technology, Gaithersburg, MD 20899

The Atomic Physics Division of the National Institute of Standards and Technology has a project underway to compile branching ratios for transitions in atomic ions of interest. So far, data have been published on H-, He-, Li-, Be-, and B-like ions, providing such ratios for transitions in ionic species of light elements. These elements (H, He, C, N, O, Ne) occur as impurity ions in high-temperature plasmas or may be conveniently introduced as trace elements for diagnostic studies. Further tabulations are planned to provide additional data on these elements.

References

[1] J. Z. Klose and W. L. Wiese, J. Quant. Spectrosc. Radiat. Transfer 42, 337 (1989).

[2] J. Z. Klose, J. R. Fuhr, M. S. Price, and W. L. Wiese, J. Quant. Spectrosc. Radiat. Transfer 48, 33 (1992).

[3] J. Z. Klose, T. M. Deters, J. R. Fuhr, and W. L. Wiese, J. Quant. Spectrosc. Radiat. Transfer, in press (1993).

15) The SMM Database of High Energy Gamma Ray Transients

Ken Levenson, Space Science Center, University of New Hampshire

The Gamma Ray Spectrometer (GRS) on the Solar Maximum Mission (SMM) satellite provided the gamma ray astronomy community with an entire decade of continuous highly stable observations in the 10 keV-100 MeV range. The GRS PI science team at the University of New Hampshire (UNH) is in the process of producing and distributing CD-ROM's containing the GRS observed solar flares and Cosmic Gamma Ray Bursts. With over 250 solar flares (emissions above 300 keV) this data set comprises the vast majority of all gamma ray solar physics. These transient events will be provided on CD ROM as high level data products in the standardized FITS format along with basic data analysis tools. As techniques are developed to better utilize this large data resource, other high level data sets will be created including near earth gamma ray transients, a catalog of solar hard x-ray events and long term high energy earth orbit background data.

The value of this solar/cosmic data base as a supplement to the current Compton Gamma Ray Observatory (CGRO) satellite instruments in the study of steady state objects is also being realized. Techniques to observe long duration cosmic hard x-ray and gamma ray sources within the GRS data may play an important role in the understanding of these objects.

Currently the UNH group voluntarily operates an informal network data service for the gamma ray community. Future plans for increasing the capability of this service could include the incorporation of on-line CD ROMs and other high level GRS data products and the possible inclusion into the "confederation" of SPDS sites. Procedures could also be developed for the requesting and delivery of large data sets in a standardized format.

This poster reviews the GRS data resource currently available at UNH via the voluntary network service, an outline of the CD ROM under production as well as other high level data sets under development which could be distributed through UNH.

16) Solar Wind Archives at M.I.T.

J. D. Richardson, J. W. Belcher, and A. J. Lazarus, Massachusetts Institute of Technology

Two of the most extensive solar wind plasma data sets have been obtained from M.I.T. plasma instruments. The M.I.T. plasma instrument on the IMP-8 spacecraft, which was launched in 1973 and has been returning information about the solar wind and magnetosheath near Earth ever since, has produced a twenty-year data base of plasma observations which is continually augmented as new data are received. The plasma science experiments on the Voyager spacecraft were launched in 1977; the plasma instrument on Voyager 1 ceased returning useful data in 1980, but Voyager 2 is still returning solar wind plasma data and is now almost 40 A.U. from the sun.

These data are available to the community on request and have been extensively used by the community. IMP-8 data are available as hourly averages and as fine resolution (1 minute) data. Parameters available are proton density, velocity, and temperature. Data are distributed electronically or as hard copy day plots showing 1 day of plasma parameters per page. The plasma group at M.I.T. currently fills about 30 requests for subsets of this data each year. The data are also archived at NSSDC, providing additional access.

Voyager data in the form of hourly averages are kept on-line at MIT. The data set is updated daily as new data are returned from Voyager. Parameters available are the plasma velocity and the proton and alpha density and temperature (alpha parameters become less available as a function of distance from the sun due to low fluxes). These data have also been freely distributed within the space science community and are included (up to 1990) in the COHO data base.

17) Opal Atomic, Equation of State, and Opacity Data

Forrest Rogers and Carlos Iglesias, Lawrence Livermore National Laboratory, Livermore, CA 94550

We have developed new methods for calculating the equation of state and opacity of astrophysical mixtures. Using these methods in conjunction with much improved atomic data (compared to that used in the Los Alamos Astrophysical Library), we have calculated extensive new data sets. A description of this new data source will be presented.

Work was performed under the auspices of the US Department of Energy by Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

18) The SCATHA Experiment: A Valuable Space Physics Data Set Ripe for Salvage

Harlan E. Spence and Joseph F. Fennell, The Aerospace Corporation, Space and Environment Technology Center, Los Angeles, CA.

In this poster, we present a summary of the space physics data available from the P78-2 satellite and describe ongoing and proposed data set salvage and restoration operations. The P78-2 satellite was a joint US Air Force and NASA flight test program aimed at investigating the effects of spacecraft charging on space vehicles. The satellite's better know moniker, SCATHA, which stands for Spacecraft Charging AT High Altitude, reflects these mission goals. For reference, a review paper by J. F. Fennell describing the satellite and experiments appeared in "The IMS Source Book" (edited by C. T. Russell and D. J. Southwood, 1982). The satellite was launched in late January 1979 and yielded continuous high-quality data for over a decade until its telemetry ceased in mid-1990. We emphasize that the SCATHA data are a <u>complete</u> data set, not merely the data from a single or limited complement of sensors. The instrumentation provided comprehensive magnetic field, electric field, wave, plasma, and energetic particle measurements within the near-geostationary environment (spacecraft apogee was ~7.8, perigee was ~5.3, and inclination was ~7.8° with apogee and perigee lying in the earth's equatorial plane). Instrument PI institutions included The Aerospace Corporation, Lockheed Palo Alto Research

Laboratories, Air Force Geophysics Laboratory, NASA (both Marshall and Goddard SFCs), University of California at San Diego, and SRI. Efforts at The Aerospace Corporation to maintain these data, even at a nominal level using only in-house resources grow more difficult with each passing year. Just recently, for instance, all of the original analog data tapes were destroyed owing to a lack of funds for their maintenance and storage. Exactly 1665 magnetic tapes of digitized days of SCATHA data were salvaged and are presently in our data storage area. We have been slowly copying these digitized tapes onto optical disks in raw form, when internal funds are available. While this is a stop-gap measure to assure the viability of the data into the future, it does not allow us to provide processed data in a way that the space physics community can readily use. In light of the present fiscal environment, it is uncertain to what extent even these modest activities can be sustained. The raw data are in telemetered form and in engineering units although computer codes exist for creating scientifically useful ephemeris, attitude, magnetic field, electric field, plasma, and energetic particle data files in time-series format. The SCATHA data represent an outstanding data base of the near-geostationary particles and fields environment and is even more valuable owing to the lack of an "Equator" satellite in the GGS/ISTP project. In addition, the SCATHA mission overlaps with many other NASA missions (e.g., ISEE, AMPTE, DE) for important retrospective, multisatellite studies. Therefore, we argue that the SCATHA data should be a high-priority data set targeted by NASA's SPDS for augmented restoration efforts.

19) Application of a Neural Network for Background Estimation in a 10 Year X-Ray Data Set

D. J. Forrest, Space Science Center, University of New Hampshire

Many data sets of interest to the space physics community are plagued by a time varying instrument background. In most cases a background estimate must be developed, tested and subtracted from the observations before the signal of interest can be studied. Techniques used to develop these background estimates are often ad hoc and require considerable familiarity with both the instrument and the data set. These requirements make these data sets decidedly user unfriendly and limit their use by the open space physics community.

We have developed techniques for making these background estimates in a general and nearly automatic way. This allows us to produce background estimates for large data sets and to include them as a part of the total data set.

The procedure involves the organization of the observed data with one of several sets of organizing geophysical parameters, which are known to influence the background rates. After individual outlying records are removed, the average data value within each geophysical parameter bin are used to train a Neural Network program. The Neural Network program is then used to generate background estimates on a record by record basis within the original data set. Usually this procedure is repeated once, using the original estimate to identify outlyers in a more reliable way. We illustrate the efficacy of this procedure with the 10 year x-ray data obtained on the GRS/SMM experiment.

20) The CEDAR Data Base

B. Emery, R. Barnes, and A. Richmond, HAO/NCAR, P. O. Box 3000, Boulder, CO 80307

Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) is sponsored by the National Science Foundation (NSF) to develop new measurement and modeling capabilities for the study of Earth's upper atmosphere. A central data base was established at the National Center for Atmospheric Research (NCAR), evolving from the earlier NCAR Incoherent Scatter Radar Data Base, to serve the international scientific community. The holdings include data from seven incoherent scatter radars, one radar that scatters from irregularities in the F-region, nine radars measuring winds in the mesosphere/lower-thermosphere region, five Fabry-Perot interferometers measuring neutral winds and temperatures, a lidar, an auroral imager, and outputs from three models. A common format of integer binaries is used, along with a similarly organized ASCII format. At present, the CEDAR Data Base contains only a small fraction of the total research data taken by ground instruments, although a more comprehensive list of ground-based instruments (currently 275) is kept. To gain access to the data, users must agree to abide by the Rules of the Road, one of which is to contact the data supplier to ensure proper use and acknowledgement. Over one-third of data requests are from foreign users. Data can be mailed on magnetic tape, Exabyte tape, PC floppy disk, or can be accessed via the CEDAR UNIX computer at NCAR. A batch system and an interactive system are available on the CEDAR computer, much of which can be transferred and used at other systems. An updated User Guide is available. The annual CEDAR Workshop is a time when users can try the system. Approximately 100 outside users have a login, of whom 17 have signed on longer than 10 hours, and 7 longer than 50 hours.

21) Rescue and Restoration of Existing Useful Space Physics Data Sets: Magnetospheric Physics

Hunter Waite[1], R. Anderson[2], D. Sibeck[3], H. H. Sauer[4], C McIlwain[5], W. W. L. Taylor[6], W. N. Spjeldvik[7], and S. Kayser[8]

Space physics data sets from many NASA-related space missions have been archived at the National Space Science Data Center (NSSDC). There are, however, undoubtedly other significant data sets (including highly processed, value added data sets) that have not yet been properly or completely archived. NASA would like to rescue and/or restore some of these data before the data storage media begin to fail or the responsible investigators lose track of the necessary details. The member of the NASA Space Physics Division/ Magnetospheric Physics Branch Data Panel would like to hear from persons in the space physics community who have data that should be considered in future archiving efforts or who would like to carry out data archiving preparation and/or value added processing archiving at the NSSDC or in other public data archives. NASA is presently evaluating the level of effort needed to rescue and restore existing data sets and establishing priorities for the required archiving tasks. Please contact Dr. J. Hunter Waite (the 1993 NASA Magnetospheric Physics Data panel chairperson) for further information.

1. Department of Space Science, Southwest Research Institute, P. O. Drawer 28510, San Antonio, TX 78228.

2. Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52242.

3. Space Department, Applied Physics Laboratory, Johns Hopkins University, Laurel, MD 20723-6099.

4. Space Environment Laboratory, 325 Broadway, Mail Code R/E/SE, NOAA/SEL, Boulder, CO 80303.

5. Physics Department, Mail Code C-011, University of California at San Diego, San Diego, CA 92093.

6. Nichols Research Corporation, 1700 N Moore Street, Suite 1820, Arlington, VA 22209.

7. NASA Headquarters, Space Physics Division, Magnetospheric Physics Branch, Code SSM, Washington, DC 20546.

8. NASA/Goddard Space Flight Center, Code 633.9, Greenbelt, MD 20771.

22) Upper Atmospheric Research Collaboratory (UARC) Project

Terry E. Weymouth, University of Michigan, Ann Arbor, MI 48109

The National Collaboratory concept has great potential for enabling "critical mass' working groups and highly interdisciplinary research projects. We report here on a large new program to build a prototype collaboratory using the Sondre Stromfjord, Greenland Upper Atmospheric Research Facility and a group of associated scientists to form a rapid prototyping, using oriented testbed. We define the collaboratory as an advanced information technology environment which enables teams to work together over distance and time on a wide variety of intellectual tasks. It provides (1) human-to-human communication using shared computer tools and work space; (2) group access and use of a network of information, data, and knowledge sources: and (3) remote access and control of instruments for data acquisition. This program will, focus on creating and evaluating, in a phased way, a collaboratory to enhance the research effectiveness of a community of scientists. The goal is to enable them to use the UARC rather than physical travel to Greenland to conduct team research campaigns. Even on short notice through the collaboratory from their home institutions, participants will be able to meet together to operate a battery of remote interactive observations and to acquire, process, and interpret the data.

23) The Southwest Data Display and Analysis System: A Tool for Space Physics

R. Murphy, Southwest Research Institute

The Southwest Data Display and Analysis System (SDDAS) is a "rapid prototyping" testbed intended to support space physics data analysis. The utility of the system relies on the availability low-cost workstation technology, a generic operating system (UNIX), and the rapid proliferation of wide area networks. The development of the SDDAS is driven from the bottom up by the user community rather than by government organizations. An interesting characteristic of the SDDAS is that it allows data from different satellites (DE 1 and DE 2) to be displayed simultaneously for a given time.

The design goals behind the next incarnation of the SDDAS are:

- Easier data access and distribution
- Easier addition of new SDDAS sites
- Support of X window interface
- Support of more diverse archive technology (e.g., DAT)

An additional goal is to make this software the center of the Particle Environment Monitor (UARS program) ground data system and to add more data to the existing archive.

Besides using "off-the-shelf" technology, the software is distributed to interested sites. This produces an informal, flexible data system with low management overhead. Rather than emphasizing the cataloging of data, the SDDAS stresses the ability to visualize data quickly. An internal data representation technique, called the Instrument Data File Set (IDFS) holds all data and metadata needed to make scientifically meaningful displays. The existing SDDAS has provided the developers with many useful "lessons learned" in the arena of space physics data systems. The developers feel that a strong case can be made that large, centralized facilities offering a fixed set of abilities will not adequately support space science in the 1990s. The SDDAS approach is adaptable to advances in computer technology, thus giving the scientist a toolbox that hopefully will aid in bridging the gap between data and scientific insight.

Appendix D

Members of Four Workshop Panels

Appendix D-1. List of Members in the Policy Panel

Name	Affiliation
Ron Zwickl (Chairman)	NOAA/Space Environment Laboratory
Richard Bogart	Stanford University
Rosana Borgen	Jet Propulsion Laboratory
Alan Burns	University of Michigan
John Cook	Naval Research Laboratory
T. Gregory Guzik	Louisiana State University
Frank Hill	National Solar Observatory
Wendell Horton	University of Texas
Cheryl Huang	University of Iowa
Umran Inan	Stanford University
Joe King	NASA/Goddard Space Flight Center
Dave Klumpar	Lockheed Palo Alto Research Laboratories
Nand Lal	NASA/Goddard Space Flight Center
Ken Levenson	University of New Hampshire
Richard McEntire	APL/Johns Hopkins University
Robert McPherron	University of California, Los Angeles
John Richardson	Massachusetts Institute of Technology
Christopher Russell	University of California, Los Angeles
Dick Shine	Lockheed Palo Alto Research Laboratories

Appendix D-2. List of Members in the Data Issues Panel

Name	Affiliation
David Sibeck (Chairman)	APL/Johns Hopkins University
Dieter Bilitza	Hughes STX
Chris Gurgiolo	Southwest Research Institute
Guan Le	University of California, Los Angeles
Noel Petit	Augsburg College
K. Roger Pyle	University of Chicago
Geoff Reeves	Los Alamos National Laboratory
Harlan Spence	The Aerospace Corporation
Neil Toy	Jet Propulsion Laboratory

Appendix D-3. List of Members in the Data Systems Panel

Name	Affiliation
Joe Gurman (Chairman)	NASA/Goddard Space Flight Center
Robert Candey	NASA/Goddard Space Flight Center
Barbara Emery	HAO/National Center for Atmospheric Research
Maria Gallagher	NASA/Ames Research Center
Tom Garrard	California Institute of Technology
Susan Hess	Jet Propulsion Laboratory
Judy Johnson	NASA/Goddard Space Flight Center
Jim Krone	Los Alamos National Laboratory
Ken Levenson	University of New Hampshire
Miah A. Mohammad	University of Arkansas at Pine Bluff
Phil Richards	University of Alabama in Huntsville
Terry E. Weymouth	University of Michigan
David Winningham	Southwest Research Institute

Appendix D-4. List of Members in the Software Panel

Name	Affiliation
Todd King (Chairman)	University of California, Los Angeles
Edgar Bering	University of Houston
Kurt Moore	Los Alamos National Laboratory
Craig Rasmussen	University of Michigan
Robert Strangeway	University of California, Los Angeles
Mark Trueblood	National Solar Observatory
Dominic Zarro	Applied Research Corporation/GSFC

Appendix E

Members of SPDS Coordinator Teams

SPDS Project Coordinators Team

Robert McGuire
NASA/Goddard Space Flight Center
Space Physics Data Facility
Code 632
Greenbelt, MD 20771
(301)286-7794
Fax: (301)286-1771
NSI/DECnet: nssdca::mcguire
Internet: mcguire@nssdca.gdfc.nasa.gov

Michael Teague
US STEP Coordination Office
Building 26, Room 201A
USRA/Goddard Space Flight Center
Code 610.3
Greenbelt, MD 20771
(301)286-4232
Fax: (301)286-9803
NSI/DECnet: nssdca::teague
Internet: teague@nssdca.gsfc.nasa.gov

SPDS Project Science Advisory Team

Robert L. McPherron (Lead)
Institute of Geophysics and Planetary Physics
University of California, Los Angeles
Los Angeles, CA 90024
(310)825-1882
Fax: (310)206-8042
NSI/DECnet: uclasp::rmcpherron
Internet: mcpherron@igpp.ucla.edu

Richard Bogart
Stanford University
ERL Building
Center for Space Science and Astrophysics
Stanford, CA 94305-4055
(415)723-1296
Fax: (415)725-2333
Internet: rbogart@solar.stanford.edu

Tom Garrard
Mail Code 220-47
California Institute of Technology
Pasadena, CA 91125
(818)395-6635
Fax: (818)449-8676
NSI/DECnet: citsrl::tlg
Internet: tlg@citsrl.srl.caltech.edu

David Sibeck
Applied Physics Laboratory/Johns Hopkins University
Johns Hopkins Road
Laurel, MD 20723-6099
(301)953-6000 x8545
Fax: (301)953-6670
NSI/DECnet: aplsp::sibeck

Dave Winningham
Southwest Research Institute
Instrumentation and Space Research Division
6220 Culebra Road
San Antonio, TX 78284-0510
(210)522-3075
Fax: (210)647-4325
NSI/DECnet: swri::david
Internet: david@dews1.space.swri.edu

ITM Discipline Coordinator Team for SPDS

Dave Winningham (Lead)
Southwest Research Institute
Instrumentation and Space Research Division
6220 Culebra Road
San Antonio, TX 78284-0510
(210)522-3075
Fax: (210)647-4325
NSI/DECnet: swri::david
Internet: david@dews1.space.swri.edu

Barbara Emery
National Center for Atmospheric Research
P. O. Box 3000
Boulder, CO 80307-3000
(303)497-1596
Fax: (303)497-1589
Internet: emery@ncar.ucar.edu

Roderick Heelis
Center for Space Sciences
P. O. Box 830688
University of Texas at Dallas
Richardson, TX 75083-0688
(214)690-2822
Fax: (214)690-2761
NSI/DECnet: utspan::utadnx::utdssa::heelis
Internet: heelis@utdallas.edu

Philip Richards
Computer Science Department
University of Alabama
Huntsville, AL 35899
(205)895-6238 x375
Fax: (205)895-6717
NSI/DECnet: cspara::richards

Edward P. Szuszczewicz
Laboratory for Atmospheric and Space Sciences
Science Applications International Corporation
1710 Goodridge Drive
Mail Stop 2-3-1
McLean, VA 22102
(703)734-5516
Fax: (703)821-1134
Internet: szusz@mclapo.saic.com

Solar Discipline Coordinator Team for SPDS

Richard Bogart (Lead)
Stanford University
ERL Building
Center for Space Science and Astrophysics
Stanford, CA 94305-4055
(415)723-1296
Fax: (415)725-2333
Internet: rbogart@solar.stanford.edu

John W. Cook
Code 7663
Naval Research Laboratory
Washington, DC 20375-5352
(202)767-2161
Fax: (202)767-5636
NSI/DECnet: 11343::cook
Internet: cook@hrts.nrl.navy.gov

Joseph Gurman
Code 682
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
(301)286-4767
Fax: (301)344-0042
NSI/DECnet: uvsp:;gurman

Frank Hill
National Solar Observatory
950 N Cherry Avenue
Tucson, AZ 85719
(602)323-4138
Fax: (602)325-9278
Internet: fhill@noao.edu

Richard A. Shine
Lockheed Palo Alto Research Laboratories
Department 91-30, Building 252
3251 Hanover Street
Palo Alto, CA 94304
(415)424-4045
Fax: (415)424-3994
Internet: shine@umbra.space.lockheed.com

Mark Trueblood
National Solar Observatory
950 N Cherry Avenue
Tucson, AZ 85719
(602)322-8519
Fax: (602)325-9278
Internet: mtrublood@noao.edu

Dominic M. Zarro
Applied Research Corporation
Code 682
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
(301)286-4689
Fax: (301)344-0042
NSI/DECnet: 15833::zarro
Internet: zarro@umbra.gsfc.nasa.gov

Magnetospheric Discipline Coordinator Team for SPDS

David Sibeck (Lead)
Applied Physics Laboratory/Johns Hopkins University
Johns Hopkins Road
Laurel, MD 20723-6099
(301)953-6000 x8545
Fax: (301)953-6670
NSI/DECnet: aplsp::sibeck

John Olsen
University of Alaska, Fairbanks
Geophysical Institute
Fairbanks, AK 99701
(907)474-7559
Fax: (907)474-7290
NSI/DECnet: fred::jvo

William Peterson
Department 91-20, Building 255
Lockheed Palo Alto Research Laboratories
3251 Hanover Street
Palo Alto, CA 94304
(415)424-3269
Fax: (415)424-3333
NSI/DECnet: lockhd::pete

Geoffrey Reeves
SST-9, Mail stop D-436
Los Alamos National Laboratory
Los Alamos, NM 87545
(505)665-3877
Fax: (505)665-4414
NSI/DECnet: essdp2::reeves
Internet: reeves@lanl.gov

Robert Strangeway
Institute of Geophysics and Planetary Physics
University of California, Los Angeles
405 Hillgard Avenue
Los Angeles, CA 90024
(310)206-6247
Fax: (213)206-3051
NSI/DECnet: brunet::strangeway
Internet: strange@igpp.ucla.edu

Howard J. Singer
NOAA R/E/SE
325 Broadway
Boulder, CO 80303-3328
(303)497-6959
Fax: (3030497-3645
NSI/DECnet: selvax:;hsinger
Internet: hsinger@selvax.sel.bldroc.gov

Cosmic and Heliospheric Discipline Coordinator Team for SPDS

Tom Garrard (Lead)
Mail Code 220-47
California Institute of Technology
Pasadena, CA 91125
(818)395-6635
Fax: (818)449-8676
NSI/DECnet: citsrl::tlg
Internet: tlg@citsrl.srl.caltech.edu

John Cooper
NSSDC/Hughes STX
Code 633.9
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
(301)513-1668
Fax: (301)513-1608
NSI/DECnet: ncf::cooper

Alan Cummings
Mail Code 220-47
California Institute of Technology
Pasadena, CA 91125
(818)356-6708
Fax: (818)449-8676
Internet: ace@citsrl.srl.caltech.edu

Paul Gazis
NASA/Ames Research Center
Mail Stop 245-3
Building 245, Room 283
Moffett Field, CA 94035-1000
(415)604-5704
Fax: (415)694-5495
NSI/DECnet:

Gregory Guzik
Department of Physics and Astronomy
Louisiana state University
Baton Rouge, LA 70803-4001
(504)388-8597
Fax: (504)388-1222
NSI/DECnet: phepds::guzik
Internet: guzik@phepds.dnet.nasa.gov

Ralph McNutt
Room 24-W153
Applied Physics Laboratory
Johns Hopkins University
Johns Hopkins Road
Laurel, MD 20723-6099
(301)953-5000 x4638
Fax: (301)953-6670
Internet: ralph_mcnutt@jhuapl.edu

Roger Pyle
University of Chicago
LASR, Enrico Fermi Institute
933 E 56th Street
Chicago, IL 60637
(312) 702-7673
Fax: (312) 702-6645
NSI/DECnet: lasr::pyle
Internet: pyle@odysseus.uchicago.edu