2002 ANNUAL STATISTICS AND HIGHLIGHTS REPORT FOR THE

NATIONAL SPACE SCIENCE DATA CENTER

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Table of Contents

PREFACE

The National Space Science Data Center, as noted in its charter, serves as the permanent archive for NASA's Office of Space Science (OSS). A major component of its mission is to ensure future data accessibility and usability. NSSDC also provides current data access, complementary to the efforts of other NASA/OSS "active archives," in support of the NASA and international astrophysics and space physics research enterprises. For 2003, a more distinct separation of statistics between NSSDC and the co-resident Sun-Earth Connection Active Archive (SECAA) is expected. Finally, NSSDC is a conduit for the general public and education community to acquire NASA space science data that may interest them.

NSSDC is pleased to issue this 2002 Annual Report describing (1) the 2002 growth and evolution of NSSDC's data archives, access pathways, and other tools and services, and (2) the 2002 access to those data and services by NSSDC's customer communities. This report has been made WWW-accessible in the hope that readers will avail themselves of the opportunity to link to the services reported herein.

The scope of this report is that of the traditional NSSDC as defined by the combined NSSDC and SECAA budgets. It should be noted that some of the activities thereby supported were the responsibilities of the Astrophysics Data Facility (no longer in existence) and the Space Physics Data Facility, both organizational peers of the formal NSSDC within Goddard's Space Science Data Operations Office.

I welcome suggestions for user-benefiting improvements to this Annual Report and to NSSDC services.

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1. INTRODUCTION

This report characterizes NSSDC's data holdings, metadata holdings, access pathways, and value-added data products, tools, and services at the end of 2002, with a focus on the 2002 activities leading to that end-of-year state. In addition, this report characterizes the nature and amount of 2002 access to NSSDC's data and services by its many users from various communities. It is assumed the reader will have a general familiarity with NSSDC and its mission. The top NSSDC web page is at http://nssdc.gsfc.nasa.gov/ .

In this era of excitement about virtual observatory concepts for a more seamless access to data, which NSSDC fully supports and expects to play role, there is also the danger of too little focus on long term preservation requirements. As the designated permanent archive for the Office of Space Science, with over 30 years experience in managing and preserving digital information now comprising thousands of data sets, NSSDC is acutely aware of the need to acquire and preserve adequate documentation to ensure the associated data are independently understandable and usable to current and future researchers.

It is NSSDC's intent to expend considerable effort, over the next few years, working with OSS disciplines, archives, and data providers to reach an OSS wide consensus on minimum standards for associated documentation in order to raise the overall quality of OSS's archived information.

2. HIGHLIGHTS

The most important result of NSSDC's 2002 activities is the continuing preservation of growing space science data volumes, ensuring their continuing and future accessibility to the space science, education, and general public communities. The statistics to follow reveal that NSSDC's archive has now grown to 21.6 TB of space science data and an additional 3.3 TB of Earth science data. During 2002, 2.3 TB of data were added to the NSSDC archive that now holds data from 1,316 experiments flown on 375 spacecraft.

Next, NSSDC continues to distribute large and growing amounts of data by network to the space science community and general public, and a fairly steady number of offline mailings to the general public. In contrast, offline tape mailings to researchers is decreasing as expected with greater reliance on internet transfers.

Again, the following statistics detail the data volumes disseminated via multiple pathways to various communities. We note here that during 2002, NSSDC's customers downloaded via network over 6.9 million data files (an 85% increase over 2001) and they received about 1.0 TB of data on mailed media.

NSSDC's data dissemination is leading to the publication of significant new science. The Appendix of this Annual Report lists >104 science papers acknowledging NSSDC data or services as contributing to their analyses. These are papers that have come to the attention of our staff. Most science journals in which NSSDC data or services may have been used are not routinely reviewed by our staff, and several which use NSSDC data/services do not cite such use, so the list represents a lower limit on papers enabled or benefited by NSSDC.

The CDAWeb system that provides access to multi-source data needed in analyses of magnetospheric processes and of solar wind-magnetosphere coupling continues to grow in popularity and usage. We have substantially expanded the number of ingest pipelines enabling data from non-core-ISTP sources to flow directly into CDAWeb rather than flowing from those sources to CDAWeb through the ISTP Central Data Handling Facility which was significantly descoped in late 2001.

The Web-based FTPBrowser family of browse/subset/retrieve interfaces at http://nssdc.gsfc.nasa.gov/ftphelper/ was expanded to about 32 space physics data sets during 2002. With rare exceptions, these data sets are not browsable via NSSDC's other interfaces. As an enhancement in functionality, an option was provided to enable users, for certain data sets, to generate scatter plots and linear regression fits with the ability to filter (include or exclude points) based on user-specified ranges of any science parameters in the data set.

A dataset of ~3,000 IMP 8 bow shock crossings for the 1994-2000 ISTP era was created collaboratively with MIT and GSFC/LEP personnel and was made accessible from the Web at http://nssdc.gsfc.nasa.gov/ftphelper/bowshock1.html. Each record contains the time and location of the crossing, observed and NSSDC-computed upstream and downstream parameter values and various flags. The interface allows the selection of records by time and/or by numeric ranges of any of the parameters in the records. This database was used to remove non-solar wind points from the OMNI data set.

NSSDC went into production on the migration of NSSDC Data Archive and Dissemination System (NDADS) data files with its reengineered data management approach in 2001. Archive Information Packages (AIP; bundles of data files and companion attribute files as prescribed by the ISO/CCSDS Archive Reference model) were defined, created and written to DLT jukebox. During 2001, 696,000 such AIPs, containing 660 GB, were created from newly arriving data and from data formerly on NDADS. At the same time the AIPs constituent data and attribute files were written to a unix-based RAID magnetic disk environment for external user access. During 2002 this migration was substantially completed with the creation of 423,000 AIPs containing 240 GB. During 2003 we will begin the creation of AIP's from the offline digital archive and their ingestion to the nearline DLT jukebox.

During 2002, the IMAGE spacecraft project continued to use NSSDC-provided software to prepare Archive Information Packages for submission to NSSDC and ingestion to the DLT jukebox. This facilitates an automated NSSDC data ingest and management pipeline. The approach will hopefully be replicated with other missions and individuals preparing data for NSSDC submission to support the rapidly growing data ingest volumes.

In 2002, the Reference Model for an Open Archival Information System (OAIS) was published by the Consultative Committee for Space Data Systems as a full standard. This effort was lead by NSSDC and has resulted in a standard that provides a conceptual model of a digital archive, including a functional view and an information view. It also provides a framework for discussing migration issues and interactions among archives. The model establishes initial criteria for recognition of a true archival function and should lead to improved archival implementations, provide a basis for further

standardization, and provide more cost-effective vendor support. It has been adopted as a starting point, in addressing digital preservation issues, by an ever growing variety of organizations including data centers, libraries, national archives, and commercial organizations around the world.

In 2002, the NASA Sun-Earth Connection Education Forum (SECEF) team, with major NSSDC participation, prepared for and orchestrated Sun-Earth Day held in April, 2003. Ten thousand packets of information were sent to teachers, scientists, etc. for Sun Earth Day programs, reaching hundreds of thousands of people. SECEF also sponsored a number of workshops and teacher professional development events reaching thousands of teachers, girl scouts, amateur astronomers, and the general public in partnership with SEC missions, museums, science centers, and planetariums as well as science and educational professional societies. The SECEF web site is available at http://sunearth.gsfc.nasa.gov/index.htm.

3. SOME SELECTED STATISTICS

(As of 12/31/02 or for 2002)

Volume of data at NSSDC: 24.9 TB

Sources of data: 1316 experiments flown on 375 spacecraft

Distinct data sets: 4417

Distinct digital media volumes: 56,161

Data volume network-accessible to customers: 1.37 TB

Data volume reaching NSSDC during 2002: 2.3 TB

Data sets with 2002-arriving data: 56

Files downloaded from NSSDC via ftp: 6,900,771

From Photo_Gallery specifically: 1,516,658

Plots made by special space physics systems: 110,737

By CDAWeb specifically: 93,587

Files downloaded from same systems: 159,305

From CDAWeb specifically: 151,655

Executions of geophysical models: 160,807

Plots/files from orbit services: 79,193

From SSCWeb specifically: 70,849

Number of offline requests satisfied: 664

Numbers of items mailed: 1,741 CD/DVD, 1,114 photoprints and slides, 211 videos

Also, 63,358 posters mailed.

Number of hits to NSSDC's web pages: 171.03 million

To NSSDC Master Catalog specifically: 2.72 million

Number of refereed papers published citing NSSDC: > 104

4. DATA MANAGED AT NSSDC, AND 2002 INFLOW AND OUTFLOW

There are several ways to characterize the multi-disciplinary NSSDC archive. Byte counts are a common metric for modern archives, and will be reported herein. Numbers of distinct data sets and numbers and diversity of media volumes managed are also very important. (In NSSDC's terminology, a data set is typically all the data from a given source at a given processing level in a given format.) The diversity of data sets and of media types relate to the intellectual heterogeneity and technical heterogeneity of the archive, respectively, and we shall report on these also.

At the end of 2002, NSSDC had 4,417 distinct data sets and accompanying documentation packages being managed. Table 1 indicates the disciplines from which these data sets come and whether the data sets are digital or non-digital (film, etc.). The table shows that these data sets come from 1,316 experiments that have flown on 375 mostly-NASA spacecraft. By data set count, space physics is the dominant discipline, accounting for nearly half of NSSDC's data sets. This reflects the fact that in its early years, NASA launched a preponderance of space physics missions and also that space physics spacecraft typically carry more independent experiments than do astrophysics missions.

Note from the table that NSSDC manages almost as many non-digital (mostly film) data sets as digital data sets, although it should be noted that NSSDC has been acquiring almost no non-digital data in recent years and has been gradually generating digital versions for parts of its film archive.

Table 2 is a different characterization of the NSSDC archive, showing byte counts and media volume

counts. The table shows 24.9 TB of total data, a 1.37 TB subset that is network-accessible, and 56,161 digital media at NSSDC. The byte counts are estimates, involving for some data sets assumptions about the mean numbers of bytes on various media types. The number of media has decreased by 16% since last year (13% the year before) as data are moved from low-capacity old media to newer high-capacity media.

Data are also being moved from NSSDC's traditional offline archive to a nearline archive based on a DLT jukebox attached to a unix server. As described within the NSSDC News pages at http://nssdc.gsfc.nasa.gov/nssdc_news/dec00/dec00_toc.html, data are newly archived in "archive information packages" which hold data files and companion attribute files as per the AIP concept of the ISO/CCSDS Open Archival Information System reference model. Table 3 shows the volumes of data ingested to this new archive, by mission, in 2001 and 2002 (661 GB and 296 GB, respectively). Much of the data were formerly network-accessible from the retired NDADS system, the bulk of which were migrated in 2001, and other data are currently inflowing to NSSDC. Most of the data were made ftp-accessible in addition.

From the research community's perspective, during 2002, only astrophysics data and space physics data are network-accessible from NSSDC. That planetary data are not network-accessible from NSSDC is the result of the Planetary Data System's making most or all its planetary data accessible via the network or via CD-ROM creation and dissemination. NSSDC's photo gallery and image catalog, which are WWW-accessible from http://nssdc.gsfc.nasa.gov/planetary/, contain much planetary image data but these are largely oriented towards the general public. However, with the closing of the Astrophysics Data Facility and its Astronomical Data Center (ADC) on 30 September, 2002, the network accessible Astrophysics data are in process of being transferred to the new Lambda archive. The ADC catalogues, derived from OSS missions, are being permanently archived by NSSDC and will not be network-accessible.

Tables 4 and 5 better characterize NSSDC's network-accessible astrophysics and space physics data for most of 2002, by project. In space physics, NSSDC holds a large volume of CDF-formatted data underlying CDAWeb and a comparably sized separate holding of data in other formats, mostly plain ASCII, and we report these separately in Table 5. There is very little overlap. All the data are ftp-accessible. All the CDF-formatted data are CDAWeb-accessible. Some of the ASCII data are accessible via FTPBrowser, ATMOWeb, or, for the long-wavelength astrophysics data, through mission-specific web pages.

The volume of data network-accessible from NSSDC is seen in Tables 4 and 5 to be 1.09 TB. The Astrophysics component of this total, or 0.12 TB, will no longer be network accessible in 2003, as previously discussed.

Table 6 characterizes the digital media types managed at NSSDC, not including back up copies. This table is an expansion of Table 2 in which total numbers of unique digital media volumes were given. It should be noted that most volumes are replicable and have one backup volume. However, for "CD-ROM (Titles)" which are not locally replicable, NSSDC typically holds between 20 and 200 copies of each title. For these, NSSDC must replenish stock through a commercial vendor as request activity drives NSSDC stock down.

Table 7 characterizes NSSDC's non-digital archive, by disciplines and by form factor. This is unchanged over the last two years. Note that NSSDC has large volumes of non-digital data for each of the discipline areas it supports. It should be noted, however, that very little new data have been arriving at NSSDC in non-digital form in recent years. NSSDC has recently begun an effort to systematically generate computer-readable versions of some of its film products. During 2002, NSSDC scanned about 6,000 large film frames from Apollo 2/4, Apollo 6, Apollo 7, Lunar Orbiter 1, Lunar Orbiter 2, and Lunar Orbiter 3.

4.1 Data Inflow

Tables 8 and 9 characterize the inflow of digital data to NSSDC during 2002. In particular, Table 8 shows that NSSDC received approximately 2.3 TB of new data in 2002, via a combination of networks and hard media. Table 8 shows data volumes by project, with the astrophysics and space physics subsets of ISTP/Wind data attributed to their respective disciplines. Dominating the counts are Level-0 data from the FAST, ISTP and IMAGE missions plus data from the ISIS and Magellan missions. Table 9 characterizes the in-flowing media types by discipline. As in recent years, CD-WO media continue as the dominant input media type overall.

During 2002, NSSDC received approximately 179 GB of data electronically, in

addition to the data arriving on the media reported in Table 9. This 179 GB

is included in the Table 8 counts and is comprised of data from IMAGE (57GB) and ISIS (122GB).

By data set count, which as noted earlier marks the intellectual heterogeneity of NSSDC, entireties or parts of 56 data sets arrived at NSSDC during 2002. A subset of these were data from the 15 new experiments.

4.2 Data Outflow

NSSDC provides user access to its data holdings through multiple electronic interfaces and, in addition, through a user support infrastructure for the mailing of offline digital and non-digital data volumes. Most electronic interfaces are accessible through NSSDC's WWW home page and include (1) special WWW-based interfaces to specific data sets or groups thereof and (2) ftp pathways to a range of data files maintained permanently on NSSDC magnetic disk. The CDF-formatted data underlying CDAWeb are at ftp://cdaweb.gsfc.nasa.gov/ while all other data are at ftp://nssdcftp.gsfc.nasa.gov/ .

The dominant special WWW-based data access interfaces that NSSDC offers to the research community relate to: ISTP key parameter and a growing range of other space physics data (CDAWeb); the OMNI and uniformized-COHO solar wind datasets (through OMNIWeb and COHOWeb, respectively); and various atmospheric and ionospheric data (ATMOWeb). In addition, FTPBrowser provides a browse/preview functionality for selected ASCII data sets otherwise only ftp-accessible.

The space physics-supportive systems are described at and accessible through http://nssdc.gsfc.nasa.gov/space/ while the astrophysics-supportive systems are accessible through http://nssdc.gsfc.nasa.gov/astro/. CDAWeb and the below-addressed SSCWeb system are primarily services of the Space Physics Data Facility, while the astrophysics services, primarily for the Education community and general public, are provided by NSSDC.

The OMNI data set is an NSSDC-created, 40 year compilation of cross-normalized, multi-spacecraft near-Earth solar wind magnetic field and plasma data and energetic particle data, while the COHOWeb database is a uniformized set of files of NSSDC-merged magnetic field, plasma, and position data for each of many deep space spacecraft. Table 10 shows annual statistics for the CDAWeb, OMNIWeb, COHOWeb, ATMOWeb and FTPBrower systems. Note the substantial usage of these systems. In 2002, they were used by NSSDC's customers to produce over 1000 plots, listings and data files every working day.

Table 11 reports statistics on the usage of NSSDC's executable geophysical models services and its services for magnetospheric and heliospheric orbits. The models service lets users specify a model, a spatial point of interest, and any other parameters on which the model depends, and have the model parameters computed at the point or along a profile through the point of interest. Table 11 shows that there were about 160,000 such computations done by NSSDC customers in 2002, with geomagnetic, ionospheric and atmospheric models dominating. This is about a 60% increase over the 99,000 model computations reported for 2001. Ftp access to models' software (95,000 file downloads in 2002) is included in ftp access statistics in Table 12, not in Table 11.

Table 11 also reveals 79,000 orbit computations, a 68% increase over 2001 which was also a 68% increase over 2000. Of these, about 89% use the primarily-magnetospheric SSCWeb service and the balance use the Heliocentric Ephemerides page.

A great many NSSDC data sets and other information services are held permanently on magnetic disk for ftp access. The reader is invited to review all these services from the ftp link on the NSSDC home page. Table 12 gives the annual counts of files downloaded, both overall (over 6.9 million files in 2002, up by 97% from 2001) and for selected directories with high activity. Note that the Photo Gallery, of high public interest, dominates the individual category statistics with 22% of the total downloads from nssdcftp. However the researcher-downloading via ftp of 490,000 CDF-formatted files from CDAWeb and 746,000 data files from the spacecraft_data subdirectory (almost five times year 2001 number) amounts to 18% and shows the high interest in and great value of these services.

WWW access statistics are frequently misleading, insofar as they usually individually count the many files (buttons, etc.) that make up a page. Nevertheless, growth in WWW accesses is indicative of continuing and growing use of the WWW-provided services. In 2002, there was an average of 14.3 million hits monthly to NSSDC's web pages, up by 10% over 2001.

While the dominant mode of dissemination of data to the research communities is via the internet,

NSSDC continues to provide a high level of offline data dissemination. Table 13 shows that NSSDC responded to over 660 distinct requests for “traditional” products and that NSSDC provided over 60,000 Milky Way and COBE posters to requesters. Table 13 also characterizes the user community of NSSDC’s offline services. To a very

large extent it is the U.S. and international general public, the education enterprise, publishers, etc. and their desire for NASA imagery on CD-ROM and as film products that account for most of NSSDC’s offline request activity.

Table 14 gives the counts of requests for offline data sets from various disciplines in 2002, and as integrated over NSSDC's history. (A small fraction of requests that are multi-disciplinary are double counted in this table.) Note particularly the dominance of planetary data over both time scales. This is largely associated with lunar and planetary image data that are widely requested by the general public. The high level of astrophysical offline activity to a large extent reflects requests by the amateur and professional astronomical communities for ADC catalogs on CD-ROM. Most offline space physics request activity was for copies of the IMAGE-based “Solar Storms” video tape.

Table 15 shows the most recent 5-year history of NSSDC's offline satellite data request activity by media type. Several points are noteworthy. The dominant mode of offline digital data dissemination continues to be by CD-ROM. It is of interest to note that every working day of 2002, NSSDC mailed about 7 CD-ROMs to 1.3 requesters. These numbers are down somewhat from 2001 (and more from 2000) as more members of the general public are able to access NSSDC’s data electronically. Also significant in Table 15 is the fact that while requests to NSSDC for film data have been trending down over the past years, the number of film products mailed have been quite steady (excluding effects of one anomalously large request satisfied in 2000. The requests for videotapes have been fairly steady over the last three years. The videotapes are as created within the GSFC/Space Science Data Operations Office.

5. ADDITIONAL NSSDC SERVICES

In addition to its archive of scientific data and the variety of data interfaces characterized in the preceding part of this Annual Report, NSSDC offers a number of additional services, which are described in this Section.

5.1 NSSDC Information Management System

The NSSDC Information Management System (NIMS) encompasses most of the separate databases that NSSDC has used to track data and information through the years. The NSSDC is in the process of incorporating its off-line data inventory system into NIMS, a task which began in earnest in 2002 and is expected to be completed in 2003.

NIMS identifies virtually all launched spacecraft, the experiments carried by many of these spacecraft, and data sets from these spacecraft primarily as archived at NSSDC. This portion of the database is the

source of information for many of NSSDC's WWW information pages. The NSSDC Master Catalog (NMC) dynamically generates WWW pages so that the latest information is presented to the user. A number of discipline and project pages are based on information derived from NIMS or utilize the NMC to generate such information.

The portion of NIMS which underlies the public NMC interface is known within NSSDC by its internal interface JEDS (for Java-based Experiment, Data set, and Spacecraft). JEDS content statistics are reported in Table 16. Note that JEDS recognizes over 5,900 spacecraft, over 5,100 experiments, and almost 5,000 data sets.

During 2002, there were 2.72 million accesses to NIMS via the NMC web interface, a 6% increase over 2001. Of these, roughly 59% and 21% were to descriptive information for spacecraft and experiments, respectively. Most accesses can be attributed to the general public.

NIMS also tracks individual published papers associated with space flight experiments. Formerly known as the Technical Reference File (TRF), publications are also a part of the JEDS portion of NIMS. The NSSDC ID for an experiment is attached to the reference information so that lists of papers relevant to a particular experiment can be reported and/or provided to persons accessing data from a given experiment. Table 17 shows that 595 papers were newly identified during 2002, most of them the result of NSSDC staffers reviewing the Journal of Geophysical Research and the Geophysical Research Letters. This portion of NIMS was used to generate the Appendix listing 74 NSSDC-acknowledged papers published in 2002.

Another portion of NIMS tracks NSSDC customer information (as well as contact information for Principal Investigators and other relevant project personnel) and our request activity for off-line data. This portion of NIMS is known as RAND (Request and Name Directory) or its internal Java-based interface, JRAND. It includes full names, one or more addresses, telephone and email information, and what NSSDC distribution lists they are on. The database was recently purged of older entries which were no longer of relevance and currently contains a bit over 58,000 entries. Additional JRAND statistics are available in Table 18. JRAND also tracks individual staff-involved requests for data, almost 670 for 2002.

NSSDC's off-line inventory database, the Interactive Data Archive (IDA), was recently incorporated into NIMS, but is not yet fully integrated into it. IDA tracks the inventory of NSSDC's digital data volumes (tapes, CD-ROMs, etc.). IDA had 171,748 records at the end of 2002, with 3,961 records having been added during the year.

5.2 NASA/Science Office of Standards and Technology (NOST) at NSSDC

NOST's mission is to facilitate the recognition and use of standards to reduce cost/benefit ratios in the exchange and management of scientific data among NASA entities and the scientific communities they serve. NOST's Web Home Page is at http://ssdoo.gsfc.nasa.gov/nost/ . The NOST strategy is to play a coordinating role in helping the science disciplines identify new standards requirements. NOST

participates in partnerships with them, other agencies, and industry on facilitating the adoption of leading-edge technologies with national or international visibility that can be tailored

to meet NASA science information management and exchange requirements, and it assists in the process of moving these technologies toward standards with commercial support.

NOST operates NASA's highest level Control Authority office in accordance with the applicable Consultative Committee for Space Data Systems (CCSDS) and ISO standards to formally archive data descriptions for interchange and long term preservation. New registrations were started, and identifiers assigned, for 2 OSO-8, and 2 Skylab data sets being migrated into archival packages on new media. As of 12/31/02, there were 441 registered identifiers.

NOST participated in the development of draft CCSDS/ISO standards applicable to multi-discipline and sub-discipline information interchange. The primary standards and their usage categories were:

Data Entity Dictionary Specification Language : This standard addresses the problem of providing a standard way to document and exchange the various attributes needed to fully define data elements. It has been harmonized with the conceptual data element standard from ISO known as ISO 11179 and the ANSI X3.L8 standard known as X3.285. The DEDSL is split into two components - one addressing the conceptual model and one addressing interchange forms. The conceptual model and an interchange form using the ISO Parameter Value Language (PVL) were completed as CCSDS standards in 2000. An interchange form using XML with DTDs was completed and published by CCSDS in January 2002. All three of these standards have also been published by ISO. These standards support the publication and exchange of data elements, and groups of data elements, and should lead to more automated access and understanding of data across science disciplines and among organizations. They can be found in the list of documents starting at: http://www.ccsds.org/CCSDS/recommandreports.jsp#interchange

Reference Model for an Open Archival Information System (OAIS): This standard provides a conceptual model of a digital archive, including a functional view and an information view, and it provides a framework for discussing migration issues and interactions among archives. The model establishes initial criteria for recognition of a true archival function and should lead to improved archival implementations, provide a basis for further standardization, and provide more cost-effective vendor support. It has been adopted as a starting point, in addressing digital preservation issues, by an ever growing variety of organizations including data centers, libraries, national archives, and commercial organizations around the world. The OAIS reference model was published as a CCSDS standard in January 2002, and subsequently as ISO standard ISO 14721:2003. It can be found at: http://www.ccsds.org/documents/650x0b1.pdf

Producer-Archive Interface Methodology Abstract Standard: This standard provides a model of the interaction between a data producer and an archive. It extends the OAIS reference model for this interface and breaks the interaction into four main phases called the Preliminary Phase, Formal Phase, Transfer, and Validation. It may be used as a checklist by archives for their negotiation with data producers, and it may be specialized by a particular community to more precisely prescribe community

standards and requirements. This standard is under review and is expected to be approved by CCSDS and ISO as full standards. It can be found at: http://www.ccsds.org/review/RPA305/651x0r1.pdf

5.3 Astronomical Data Center

The Astronomical Data Center (ADC) (http://adc.gsfc.nasa.gov/), with over 3700 astronomical source catalogs and journal tables, was maintained until ADC closure on September 30, 2002. The web site and supporting software was maintained for several months beyond this date, but a security issue and lack of resources forced a more complete termination of service. When the services were available, the entire collection of catalogs and tables could be retrieved via FTP. Web-based visualization tools were available for browsing, plotting, and subsetting the contents of the catalogs and tables before download. Users could query interactively for information on individual plotted data points and search for observations made by NASA missions.

ADC staff members conducted research using the eXtensible Markup Language (XML), and ADC users are benefiting from this effort. Among other XML-based services, they created a form-based metadata search capability that takes advantage of various browse indices (author, keyword, etc.). Access to the ADC's XML Public Archive remain available on the Web at http://xml.gsfc.nasa.gov/archive/. The ADC's research activities and data holdings are highly relevant to the development of a National Virtual Observatory. During 2002 ADC staff participated in several NVO meetings and worked on the NSF-funded NVO Framework project, and gave talks at four universities.

Project AstroData, a pilot series of on-line science education tutorials and exercises for K-12 students created by ADC staff, has been moved to http://nvo.gsfc.nasa.gov/astrodata/.

5.4 Common Data Format

The NSSDC Common Data Format (CDF) is a self-describing platform-independent data format for the storage and manipulation of multidimensional data in a discipline-independent fashion. CDF is comprised of three parts, the CDF data files that contain both the actual data values and metadata, the CDF software library that is used to create, access, manage, manipulate, etc. CDF files, and a well-defined Applications Programming Interface (known as the CDF Interface) that provides transparent access to underlying software and data. The NASA ISTP and IMAGE missions and the ESA Cluster mission use CDF extensively. We also note that CDF underlies NSSDC's OMNIWeb, COHOWeb, CDAWeb and SSCWeb services.

During 2002, the CDF office developed, in a bid to facilitate and promote data sharing with other data formats, a FITS-to-CDF translator and two XML tools (CDF2CDFML and CDFML2CDF) that are based on the CDF Markup Language (CDFML), an XML language used to represent CDF data and metadata. CDF2CDFML exports the contents of a CDF file into an XML form and CDFML2CDF creates a CDF file from a CDFML file. The CDF office also addressed the CDF distribution usability issues by automating the CDF library installation process for the Windows and Macintosh OS X users. In addition,

a tool was developed to produce a SEC-compliant CDF file from a generic CDF file and a master CDF file.

A web page at http://nssdc.gsfc.nasa.gov/cdf/ provides a description of CDF, access to the software distribution, documentation, papers, a list of Frequently Asked Questions, and facilitates interaction with the CDF support group at the NSSDC.

Approximately 20,703 files were FTP-downloaded from the CDF directory of NSSDC's anonymous account during 2002. These were mostly files describing CDF, software tools from the CDF library, etc. In addition, a great many users browse the CDF web pages identified above.

Glossary

ACE	Advanced Composition Explorer
ADC	Astronomical Data Center
AE	Atmospheric Explorer
AEROS	AERONomy Satellite
AIP	Archive Information Package
ARCAD	Arc Aurorale et Densite
ASCII	American Standard Code for information Interchange
CANOPUS	Canadian Auroral Network for the OPEN Program Unified Study
CCSDS	Consultative Committee for Space Data Systems
CD-ROM	Compact Dist-Read Only Memory
CD-WO	Compact Disk-Write Once

CDAW	Coordinated Data Analysis Workshop
CDF	Common Data Format
COBE	Cosmic Background Explorer
COHO	Coordinated Heliospheric Observations
CRRES	Chemical Release and Radiation Effects Satellite
DARN	Dual Auroral Radar Network
DE	Dynamics Explorer
DEDSL	Data Entity Dictionary Specification Language
DLT	Digital Linear Tape
DTD	Data Type Description
DVD	Digital Versatile Disk (originally, V = video)
DVD-WO	Digital Versatile Disk-Write Once
EOSDIS	Earth Observing System Data and Information System
FAST	Fast Auroral SnapshoT
FITS	Flexible Image Transport System
FTP	File Transfer Protocol
GB	Gigabyte
GOES	Geostationary Observational Environmental Satellite
GSFC	Goddard Space Fligbht Center

IDA	Interactive Data Archive
IMAGE	Imager for Magnetopause-to-Aurora Global Exploration
IMP	Interplanetary Monitoring Platform
IRAS	Infrared Astronomical Satellite
ISEE	International Sun-Earth Explorer
ISIS	International Satellite for Ionosphere Studies
ISO	International Organization for Standardization
ISTP	International Solar-Terrestrial Physics
JEDS	Java Experiments, Data sets, Spacecraft
JRAND	Java Request and Name Directory
KP	Key Parameters
LANL	Los Alamos National Laboratory
LEP	Low Energy Particle
MAGSAT	MAGnetic field SATellite
MIT	Massachusetts Institute of Technology
M-O	Magneto-optic
MSIS	Mass Spectrometer and Incoherent Scatter
NASA	National Aeronautics and Space Administration
NDADS	NSSDC Data Archive and Distribution System

NEAR	Near Earth Asteroid Rendezvous
NIMS	NSSDC Information Management System
NMC	NSSDC Master Catalog
NOST	NASA/Science Office of Standards and Technology
NSSDC	National Space Science Data Center
NVO	National Virtual Observatory
OAIS	Open Archival Information System
OMNI	Interplanetary Medium Data (not an acronym)
OSO	Orbiting Solar Observatory
OSS	Office of Space Science
RAID	Redundant Array of Independent Disks (originally, “I” was “Inexpensive”)
SAMPEX	Solar Anomalous and Magnetospheric Particle Explorer
SEC	Sun Earth Connection
SECAA	Sun Earth Connection Active Archive
SECEF	Sun Earth Connection Education Forum
SNOE	Student Nitrogen Oxide Explorer
SOHO	Solar and Heliospheric Observatory
SSC	Satellite Situation Center

SWAS	Submillimeter Wave Astronomy Satellite
TB	Terabyte
TRF	Technical Reference File
WORM	Write-Once, Read-Many
WWW	World Wide Web
XDF	eXtensible Data Format
XML	eXtensible Markup Language

Tables 1-18

Table 1. Counts of NSSDC Data Sets and Data Set Sources December 31, 2002

Discipline	Digital	Non-Digital	Totals	Exps w. Data	S/C w. Data
Astronomy	237	75	312	92	23
Space/Solar Physics	1,274	660	1,934	756	217
Planetary	633	749	1,382	335	84
Earth	130	124	254	122	49
Other	97*	438*	535	11	2
Totals	2,370	2,046	4,417	1,316	375

* "Other" includes 94 digital and 426 non-digital ephemeris data sets.

Table 2. State of the NSSDC Archive December 31,

2002

	Number of TeraBytes	No. of TeraBytes Network-Accessible	Number of Media (Digital)*
Astro	5.4	0.12	2,162
Space Physics	11.4	1.37	20,219
Planetary	4.7	0	13,003
Earth	3.3	0	20,397**
Other	0.1	0	308
Total	24.9	1.49	56,161

* See Table 6 for detail; not counted is large quantity of data on microfilm, microfiche, etc.

** Awaiting transfer to EOSDIS

Table 3. Data Migrated to Nearline Permanent Archive

	2001		2002	
	Files/1000	GB	Files/1000	GB
IMP8	0.9	1.6	0.01	0.02
ISIS	594.2	328.4	243.43	122.4
DE	71.6	193.3	4.52	2.93
IMAGE	5.5	77.5	4.62	57.38
IRAS	12.6	14	144.96	80.56
ISEE	4.2	1.6	1.03	0.09
SAMPEX	6.8	44.2	0.95	5.83
OSO-8			3.65	4.06
PIONEER			0.28	0.520
SANMARCO			0.01	0.010
ULYSSES			13.22	0.830
VOYAGER			8.65	20.650
WIND			1.94	1.090
Totals	695.8	660.6	427.27	296.37

Table 4. Astrophysics Data Electronically Accessible from NSSDC

December 31, 2002

ADC	19.6 GB
COBE	28.0
IRAS	75.7
SWAS	1.3
Totals	124.6 GB

Table 5. Space Physics Data Electronically Accessible from NSSDC

December 31, 2002

Spacecraft/Ground Station	CDAWeb	ftp://nssdcftp/spacecraft_data
----------	----------	----------
ACE	1.7 GB	4.6 GB
Cluster	19	
CRRES		32
Darn	4	
DE	20.5	170
FAST	50	
GOES	1.8	
Geotail	94.8	
Ground-based	5.9	
Hawkeye	2.5	
IMAGE	193	124
IMP 8	4	20
Interball	1.1	
ISEE		5.8
ISIS 1&2	91	126

LANL 1	5.2	
MAGSAT		1.7
Polar	259	1.3
Radiation	4.5	
SAMPEX	5.9	47
Ulysses	3.2	10
Voyager		21
Wind	20	10
Other	4.3*	5.1**
Totals	791.2 GB	578.5 GB

* includes <1GB per spacecraft/ground station from SOHO, Helios1, Equator-S, CANOPUS, Sesame, Sondstrom

** includes <1Gbspacecraft from AE-C,-D,-E, AEROS, Alouette, ARCAD, Explorers 22 and 31, Galileo, Helios 1 and 2, Hinotori, Mariner 10, Pioneer 10 and 11, Prognoz 6,7, and 9, San Marco, SNOE, and several additional Soviet spacecraft.

Table 6. Counts of Volumes at NSSDC Archive on December 31, 2002

	Astro Physics	Space Physics	Planetary Science	Earth Science	Total*
4-mm Tape	24	77	1	97	199
8-mm Tape	90	510	74	0	674
9-Track Tape	549	2,945	8,307	17,315	29,116
3480Cartridges	758	1,766	977	2,918	6,419
DLT	176	35	0	0	211
CD-ROM (Titles)	38	364	1,070	25	1,497
CD-WO	285	14,369	2,561	0	17,215
DVD	0	0	3	0	3
DVD-WO	0	72	0	0	21
12" Worm	0	54	0	0	54
M-O Disk	241	0	0	0	241

Floppy Disk	1	27	10	42	80
Totals	2,162	20,219	13,003	20,397	56,161*

Backup volumes not included

* Additional 380 volumes managed not attributable to these 4 disciplines

Table 7. Photographic Data Products at NSSDC by Discipline

Discipline	Micro film	Micro fiche	Film (feet)	Film (Frames)	Reels	Slides
Astrophysics	6,020	18,524	100	63,459		121
Earth Science	1,430		4,200	236,066		
Planetary Science	3,294	6,345	143,214	392,122	259	25
Space Physics	20,195	14,669	4,640	4,379		41,509
Communications	183					
Other	162					
Totals	31,284	39,538	152,154	696,026	259	41,555

Table 8. Data Arriving at NSSDC During 2002

Astrophysics	GB	Planetary	GB	Space Physics	GB
Wind	2.25	**Mars Global Survyr**	2.96	**ACE**	20.17

				DE	1.59
		Galileo	1.80	**FAST**	598.86
				IMAGE	57.38
		NEAR	86.83	**IMP-8**	5.20
				ISIS	122.40
		Magellan	660.78	**ISTP**	
				KP'S	9.17
				Geotail	140.12
				Polar LO	247.87
				Wind LO +	36.77
				Cluster	306.99
				SAMPEX	12.15
				Ulysses	7.30
Subtotal	2.25		752.37		1,565.97
Grand Total	2,321 GB				

Table 9. Media Arriving at NSSDC During 2002

	Astro Physics	Space Physics	Planetary Science	Total
	---	---	---	---
CD-ROM (Titles)	0	20	8	28
CD-WO	12	2,633	1,080	3,725
DVD-WO	0	56	0	56
M-O Disk	0	23	0	23
Totals	12	2,732	1,088	3,832

Table 10. Annual Access Statistics for Special Space Physics Systems

	2000	2001	2002
	---	---	---
CDAWeb*	88,642/33,234	100,199/59,965	93,587/151,655
OMNIWeb*	9,129/2,606	11,123/9,404	12,108/6,896
COHOWeb*	1,144/202	2,954/633	2,537/300
ATMOWeb*	1,715/525	2,185/518	779/163
FTPBrowser*	N/A	N/A	1,726/292

* First member of each pair is the number of plots created. Second member is the sum of numerical screen listings plus user-created ASCII files or CDF files downloaded.

Table 11. 2002 Access Statistics to Geophysical Models and Ephemerides Services

Geophysical Models	**Accesses***

International Reference Ionosphere	45,659
MSIS Atmospheric Model	64,943
International Geomagnetic Reference Field (Includes Corrected Geomagnetic Coordinate Transformations)	27,950
Tsyganenko 1989, 1996 Magnetic Field	19,234
Trapped Particles	3,021
Total, Geophysical Models	160,807
Satellite Situation Center/SSCWeb	
(magnetosphere and near-magnetosphere spacecraft orbits)	
Plots	28,277
Tabular and "Query"	42,572
Total, SSCWeb	70,849
Heliocentric Spacecraft, Planets, Comets Orbits	8,344

* These counts are software executions, yielding results for user-specified criteria. They do not

include ftp-downloads of corresponding software.

Table 12. Number of Files Downloaded via FTP

	1999	2000	2001	2002
	---	---	---	---
Photo Gallery	1,381,000	1,918,000	2,888,000	1,516,658
Spacecraft Data	113,000	76,000	155,000	746,008
Geophysical Models	N/A	N/A	95,000	95,957
All others on nssdcftp	229,000	290,000	195,000	179,277
CDF'd data on CDAWeb	N/A	N/A	201,000	489,590
Total	1,723,000	2,284,000	3,534,000	3,014,490

Table 13. NSSDC User Community (Offline Requests Only) [CY 2002]

Affiliation Category	Total Requests	Percent of Total
No Affiliation [General Public]	249	37.4
Non-US	193	29.0
US Universities/Colleges	107	16.1
US Private Industry	51	7.8
NASA/GSFC	24	3.6
NASA Centers, Excluding GSFC	6	0.9
Other Government Agencies	22	3.4
Miscellaneous	12	1.8
Total	664*	100

* Requests for 53,113 Milky Way posters and 7,245 COBE posters are not included in this total. Note that this poster request level was about seven times the number requested in 2001.

Table 14. Number of Requests for Offline Satellite Data from NSSDC by Discipline *

Discipline	Data Set Requests 1968 - 2002	Data Set Requests 2002
Astrophysics	11,368	139
Earth Science	7,135	3
Planetary Science	46,512	789
Space Physics	8,948	159
Ephemeris	88	0
Other	21	1

Total	74,072	1,091

* One request for all or parts of two distinct data sets adds two to these Table 14 statistics, but only one to the Table 13 statistics.

Table 15. NSSDC Offline Data Dissemination Statistics as of December 31, 2002

Offline	1998	1999	2000	2001	2002
Number of requests for CDs	1,079	1,013	632	433	342
Number of CDs mailed	6,825	7,014	4,387	2,241	1,741
Number of film requests	300	230	240	111	124
Number of film volumes mailed	2,353	1,520	6,573	2,494	1,114
Number of videotape requests			168	98	100
Number of videotapes mailed			231	280	211
Number of magnetic tape requests					2
Number of magnetic tapes mailed					5

Table 16. NIMS/JEDS Database Statistics for CY 2002

Subpartition	Number of Records as of 12/31/01	Number Added in 2002
Spacecraft	5,906	96
Experiment	5,105	55
Data Set	4,969*	56

Totals	15,970	207

*The decrease in this number was due to the merging of many data sets.

Number of spacecraft with experiment records - 1,024

Number of experiments with data sets at NSSDC - 1,316

Table 17. NIMS/TRF (Bibliographic) Partition Statistics as of December 31, 2002

Total Number of Records	43,647
Number of Records Inserted in 2002	595

Table 18. NIMS/JRAND Partition Statistics as of December 31, 2002

Record Type	Total Records	Records Inserted	Records Updated
Personnel	58,110	761	3,002
Request	83,319	669	

Appendix - Listing of 2002-Published, NSSDC-Acknowledged Papers

B52562 Anderson, P. C., Chen, M. W.

Examination of the storm/substorm relationship using global auroral X-ray images

J. Geophys. Res., 107, No. A10, Oct. 2002.

B52192 Andersson, L., Ivchenko, N., Clemmons, J., Namagaladze, A. A., Gustavsson, B.

Electron signatures and alfven waves

J. Geophys. Res., 107, No. A9, Sept. 2002.

B51825 Anttila, A., Torsti, J.

Energetic particles during the first two years of SOHO science mission

Adv. Space Res., 29, No. 3, 319-324, 2002.

B52183 Ballatore, P.

Effects of fast and slow solar wind on the correlations between interplanetary medium and geomagnetic activity

J. Geophys. Res., 107, No. A9, Sept. 2002.

B52485 Blanchard, G. T., Bankston, D.

Improved interplanetary magnetic field propagation timing by correction of the phase front orientation using two spacecraft

J. Geophys. Res., 107, No. A12, Dec. 2002.

B52048 Boberg, F., Lundstedt, H.

Solar wind variations related to fluctuations of the North Atlantic Oscillation

Geophys. Res. Lett., 29, No. 15, Aug. 2002.

B52083 Bothmer, V., Veselovsky, I. S., Dmitriev, A. V., Zhukov, A. N., Cargill, P.

Solar and heliospheric causes of geomagnetic perturbations during the growth phase of solar cycle 23

Solar Syst. Res., 36, No. 6, 499-506, 2002.

B52545 Brandt, P. C., Ebihara, Y., Barabash, S., Roelof, E. C.

Energetic neutral atom images of a narrow flow channel from the plasma

sheet: Astrid-1 observations

J. Geophys. Res., 107, No. A10, Oct. 2002.

B52373 Burlaga, L. F., Ness, N. F., Wang, Y. -M., Sheeley, N. R., Jr.

Heliospheric magnetic field strength and polarity from 1 to 81 AU during the ascending phase of solar cycle 23

J. Geophys. Res., 107, No. A11, Nov. 2002.

B52570 Cane, H. V., Erickson, W. C., Prestage, N. P.

Solar flares, type III radio bursts, coronal mass ejections, and energetic particles

J. Geophys. Res., 107, No. A10, Oct. 2002.

B51854 Cattell, C., Crumley, J., Dombeck, J., Wygant, J., Mozer, F. S.

Polar observations of solitary waves at the Earth's magnetopause

Geophys. Res. Lett., 29, No. 5, 9-1/9-4, Mar. 2002.

B52550 Cheng, C.-C., Russell, C. T., Connors, M., Chi, P. J.

Relationship between multiple substorm onsets and the IMF: A case study

J. Geophys. Res., 107, No. A10, Oct. 2002.

B52559 Chrisham, G., Coleman, I. J., Freeman, M. P., Pinnock, M., Lester, M.

Ionospheric signatures of split reconnection X-lines during conditions of IMF Bz < 0 and |By| ~ |Bz|: Evidence for the antiparallel merging hypothesis

J. Geophys. Res., 107, No. A10, Oct. 2002.

B51821 Christiansen, F., Papitashvili, V. O., Neubert, T.

Seasonal variations of high-latitude field-aligned currents inferred from Orsted and Magsat observations

J. Geophys. Res., 107, No. A2, 5-1/5-13, Feb. 2002.

B51853 Christon, S. P., Mall, U., Eastman, T. E., Gloeckler, G., Lui, A. T. Y.

Solar cycle and geomagnetic N+1/O+1 variation in outer dayside magnetosphere: Possible relation to topside ionosphere

Geophys. Res. Lett., 29, No. 5, 2-1/2-4, Mar. 2002.

B51963 Dasso, S., Gomez, D., Mandrini, C. H.

Ring current decay rates of magnetic storms: A statistical study from 1957 to 1998

J. Geophys. Res., 107, No. A5, May 2002.

B52251 Denton, R. E., Lee, D. H., Takahashi, K., Goldstein, J., Anderson, R.

Quantitative test of the cavity resonance explanation of plasmaspheric Pi2 frequencies

J. Geophys. Res., 107, No. A7, July 2002.

B52354 Denton, R. E., Goldstein, J., Menietti, J. D., Young, S. L.

Magnetospheric electron density model inferred from Polar plasma wave data

J. Geophys. Res., 107, No. A11, Nov. 2002.

B52446 Denton, R. E., Goldstein, J., Menietti, J. D.

Field line dependence of magnetospheric electron density

Geophys. Res. Lett., 29, No. 24, Dec. 2002.

B51962 Dubinin, E., Skalsky, A., Song, P., Savin, S., Kozyra, J.

Polar-Interball coordinated observations of plasma and magnetic field

characteristics in the regions of the northern and southern distant cusps

J. Geophys. Res., 107, No. A5, May 2002.

B52184 Dunlop, M. W., Lucek, E. A., Kistler, L. M., Cargill, P.,

Balogh, A.

Equator-S observations of ion cyclotron waves outside the dawnside magnetopause

J. Geophys. Res., 107, No. A9, Sept. 2002.

B52320 Ebihara, Y., Ejiri, M., Nilsson, H., Sandahl, I., Milillo, A.

Statistical distribution of the storm-time proton ring current: POLAR measurements

Geophys. Res. Lett., 29, No. 20, Oct. 2002.

B52471 Engebretson, M. J., Peterson, W. K., Posch, J. L., Klatt, M. R., Anderson, B. J.

Observations of two types of Pc 1-2 pulsations in the outer dayside magnetosphere

J. Geophys. Res., 107, No. A12, Dec. 2002.

B52203 Farrugia, C. J., Popecki, M., Moebius, E., Jordanova, V. K., Desai, M. I.

Wind and ACE observations during the great flow of 1-4 May 1998: Relation to solar activity and implications for the magnetosphere

J. Geophys. Res., 107, No. A9, Sept. 2002.

B52341 Frank, L. A., Paterson, W. R., Sigwarth, J. B.

Observations of plasma injection into the ring current during substorm expansive phase

J. Geophys. Res., 107, No. A11, Nov. 2002.

B52228 Frey, H. U., Mende, S. B., Immel, T. J., Fuselier, S. A., Claflin, E. S.

Proton aurora in the cusp

J. Geophys. Res., 107, No. A7, July 2002.

B52182 Fuselier, S. A., Berchem, J., Trattner, K. J., Friedel, R.

Tracing ions in the cusp and low-latitude boundary layer using multispacecraft observations and a global MHD simulation

J. Geophys. Res., 107, No. A9, Sept. 2002.

B52223 Fuselier, S. A., Frey, H. U., Trattner, K. J., Mende, S. B., Burch, J. L.

Cusp aurora dependence on interplanetary magnetic field Bz

J. Geophys. Res., 107, No. A7, July 2002.

B52229 Ganushkina, N. Y., Pulkkinen, T. I., Kubyshkina, M. V., Singer, H. J., Russell, C. T.

Modeling the ring current magnetic field during storms

J. Geophys. Res., 107, No. A7, July 2002.

B52061 Goldstein, J., Spiro, R. W., Reiff, P. H., Wolf, R. A., Sandel, B. R.

IMF-driven overshielding electric field and the origin of the plasmaspheric shoulder of May 24, 2000

Geophys. Res. Lett., 29, No. 16, Aug. 2002.

B52337 Hashimoto, K. K., Kikuchi, T., Ebihara, Y.

Response of the magnetospheric convection to sudden interplanetary magnetic field changes as deduced from the evolution of partial ring currents

J. Geophys. Res., 107, No. A11, Nov. 2002.

B51751 Hidalgo, M. A., Cid, C., Vinas, A. F., Sequeiros, J.

A non-force-free approach to the topology of magnetic clouds in the solar wind

J. Geophys. Res., 107, No. A1, 1-1/1-7, Jan. 2002.

B52431 Hidalgo, M. A., Nieves-Chinchilla, T., Cid, C.

Elliptical cross-section model for the magnetic topology of

magnetic clouds

Geophys. Res. Lett., 29, No. 13, July 2002.

B52250 Hu, Q., Sonnerup, B. U. O.

Reconstruction of magnetic clouds in the solar wind: Orientations and configurations

J. Geophys. Res., 107, No. A7, July 2002.

B51814 Huang, C.-S., Foster, J. C., Song, P., Sofko, G. J., Frank, L. A.

Geotail observations of magnetospheric midtail during an extended period of strongly northward interplanetery magnetic field

Geophys. Res. Lett., 29, No. 4, 15-1/15-4, Feb. 2002.

B52274 Huang, C.-S., Foster, J. C., Erickson, P. J.

Effects of solar wind variations on the midlatitude ionosphere

J. Geophys. Res., 107, No. A8, Aug. 2002.

B52240 Huttunen, K. E. J., Koskinen, H. E. J., Schwenn, R.

Variability of magnetospheric storms driven by different solar wind pertubations

J. Geophys. Res., 107, No. A7, July 2002.

B52468 Huttunen, K. E. J., Koskinen, H. E. J., Pulkkinen, T. I., Pulkkinen, A., Palmroth, M.

April 2000 magnetic storm: Solar wind driver and magnetospheric response

J. Geophys. Res., 107, No. A12, Dec. 2002.

B52273 Innis, J. L., Conde, M.

High-latitude thermospheric vertical wind activity from Dynamics Explorer 2 Wind and Temperature Spectrometer observations: Indications of a source region for polar cap gravity waves

J. Geophys. Res., 107, No. A8, Aug. 2002.

B52449 Innis, J. L., Conde, M.

Characterization of acoustic-gravity waves in the upper thermosphere using Dynamics Explorer 2 Wind and Temperature Spectrometer (WATS) and Neutral Atmosphere Composition Spectrometer (NACS) data

J. Geophys. Res., 107, No. A12, Dec. 2002.

B52555 Joy, S. P., Kivelson, M. G., Walker, R. J., Khurana, K. K., Russell, C. T.

Probabilistic models of the Jovian magnetopause and bow shock locations

J. Geophys. Res., 107, No. A10, Oct. 2002.

B52480 Kadokura, A., Yukimatu, A.-S., Ejiri, M., Oguti, T., Pinnock, M.

Detailed analysis of a substorm event on 6 and 7 June 1989 1. Growth phase evolution of nightside auroral activities and ionospheric convection toward expansion phase onset

J. Geophys. Res., 107, No. A12, Dec. 2002.

B52481 Kadokura, A., Yukimatu, A.-S., Ejiri, M., Oguti, T., Pinnock, M.

Detailed analysis of a substorm event on 6 and 7 June 1989: 2. Stepwise auroral bulge evolution during expansion phase

J. Geophys. Res., 107, No. A12, Dec. 2002.

B52473 Kataoka, R., Fukunishi, H., Lanzerotti, L. J., Rosenberg, T. J., Weatherwax, A. T.

Traveling convection vortices induced by solar wind tangential discontinuities

J. Geophys. Res., 107, No. A12, Dec. 2002.

B52362 Kim, K.-H., Cattell, C. A., Lee, D.-H., Takahashi, K., Yumoto, K.

Magnetospheric responses to sudden and quasiperiodic solar wind variations

J. Geophys. Res., 107, No. A11, Nov. 2002.

B52097 Koleva, R., Fedorov, A., Semkova, J., Smirnov, V.

Low energy species identification in magnetospheric boundary layers: Case study

Adv. Space Res., 30, No. 7, 1757-1760, 2002.

B52342 Korotova, G. I., Sibeck, D. G., Singer, H. J., Rosenberg, T. J.

Tracking transient events through geosynchronous orbit and in the high-latitude ionosphere

J. Geophys. Res., 107, No. A11, Nov. 2002.

B52086 Kotova, G. A., Bezrukikh, V. V., Verigin, M. I., Lezhen, L. A.

Temperature and density variations in the dusk and dawn plasmasphere as observed by Interball Tail in 1999-2000

Adv. Space Res., 30, No. 7, 1831-1834, 2002.

B51818 Kozlovsky, A., Kangas, J.

Motion and origin of noon high-latitude poleward moving auroral arcs on closed magnetic field lines

J. Geophys. Res., 107, No. A2, 1-1/1-13, Feb. 2002.

B52451 Kozlovsky, A., Koustov, A., Lyatsky, W., Kangas, J., Parks, G.

Ionospheric convection in the postnoon auroral oval: Super Dual Auroral Radar Network (SuperDARN) and polar ultraviolet imager (UVI) observations

J. Geophys. Res., 107, No. A12, Dec. 2002.

B52304 Kozyra, J. U., Liemohn, M. W., Clauer, C. R., Ridley, A. J., Thomsen, M. F.

Multistep Dst development and ring current composition changes during the 4-6 June 1991 magnetic storm

J. Geophys. Res., 107, No. A8, Aug. 2002.

B52346 Kullen, A., Brittnacher, M., Cumnock, J. A., Blomberg, L. G.

Solar wind dependence of the occurrence and motion of polar auroral arcs: A statistical study

J. Geophys. Res., 107, No. A11, Nov. 2002.

B51871 Landgraf, M., Liou, J.-C., Zook, H. A., Gruen, E.

Origins of solar system dust beyond Jupiter

Astron. J., 123, No. 5, 2857-2861, May 2002.

B52408 Lario, D., Decker, R. B.

The energetic storm particle event of October 20, 1989

Geophys. Res. Lett., 29, No. 10, May 2002.

B52323 Lavraud, B., Dunlop, M. W., Phan, T. D., Reme, H., Bosqued, J.-M.

Cluster observations of the exterior cusp and its surrounding boundaries under northward IMF

Geophys. Res. Lett., 29, No. 20, Oct. 2002.

B52255 Lawler, A.

Panel plots clear path for planetary program

Science, 297, No. 5580, 317-318, July 2002.

B51845 Le Vine, D. M., Abraham, S.

The effect of the ionosphere on remote sensing of sea surface salinity from space: Absorption and emission at L band

IEEE Trans. Geosc. Remote Sensing, 40, No. 4, Apr. 2002.

B52478 Le, G., Lu, G., Strangeway, R. J., Pfaff, R. F., Jr.

Strong interplanetary magnetic field By-related plasma convection in the ionosphere and cusp field-aligned currents under northward interplanetary magnetic field conditions

J. Geophys. Res., 107, No. A12, Dec. 2002.

B52202 Leamon, R. J., Canfield, R. C., Pevtsov, A. A.

Properties of magnetic clouds and geomagnetic storms associated with eruption of coronal sigmoids

J. Geophys. Res., 107, No. A9, Sept. 2002.

B52347 Lee, D.-Y., Min, K. W.

Statistical features of substorm indicators during geomagnetic storms

J. Geophys. Res., 107, No. A11, Nov. 2002.

B51957 Liemohn, M. W., Kozyra, J. U., Clauer, C. R., Khazanov, G. V., Thomsen, M. F.

Adiabatic energization in the ring current and its relation to other source and loss terms

J. Geophys. Res., 107, No. A4, Apr. 2002.

B52484 Lockwood, M.

Relationship between the near-Earth interplanetary field and the coronal source flux: Dependence on timescale

J. Geophys. Res., 107, No. A12, Dec. 2002.

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