

**2008 ANNUAL STATISTICS AND HIGHLIGHTS REPORT FOR
THE
NATIONAL SPACE SCIENCE DATA CENTER**

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2009-2-27

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PREFACE

The National Space Science Data Center (NSSDC) 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. Finally, NSSDC is a conduit for the general public and education community to acquire NASA space science data that may interest them.

Herein we report on the activities of the NSSDC for the calendar year 2008. As much as possible, we report the same statistics as in previous years to enable interested parties who wish to compare accomplishments year-to-year. Nevertheless, as NSSDC evolves, some statistical tables have been updated to better reflect current operations. This report covers only the NSSDC. Reports before 2003 covered both the NSSDC and the Space Physics Data Facility (SPDF), who were organizational peers within the GSFC Space Sciences Data Operations Office (SSDOO). Following a NASA reorganization the two entities are now in separate GSFC divisions, NSSDC within the Solar System Exploration Division and SPDF within the Heliophysics Science Division. Note also that many statistics in this report are only comparable to those from the 2005 and later, since our central NIMS database was revamped in 2005.

NSSDC is pleased to issue this 2008 Annual Report describing the 2008 growth and evolution of NSSDC's data archives, access pathways, and other tools and services, as well as the 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.

I welcome suggestions from users for improvements to this Annual Report and to NSSDC services.

Edwin J. Grayzeck

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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 2008, with a focus on the 2008 activities leading to that end-of-year state. In addition this report characterizes the nature and 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. For more information see the top NSSDC web page at <http://nssdc.gsfc.nasa.gov/> .

In 2005 we assembled an external user group, the NSSDC User Group (NUG), which meets annually to advise us on our short and long range goals. The group's reports, most recently from February 2007, are on-line and can be linked to from the NSSDC homepage. The 2008 meeting was deferred until early 2009.

2. SOME SELECTED STATISTICS

Key statistics for 2008 or totals as of 12/31/08 include:

Volume of data at NSSDC: 77.3 TB

Distinct datasets: 4452

Distinct digital media volumes: 65,934

Media Volumes arriving in 2008: 1063

Data volume reaching NSSDC during 2008: 24.0 TB

Datasets (total) with data ingested in 2008: 45

Datasets of legacy data ingested in 2008: 146

Files downloaded from NSSDC via ftp: 2,971,521

Number of offline requests satisfied: 88

3. HIGHLIGHTS

The center of this report is the 13 Tables which summarize NSSDC activities in 2008. In most cases these numbers speak for themselves, though it is irresistible to address a few highlights.

The most important result of NSSDC's 2008 continuing activities is the preservation of growing space science data volumes, ensuring their continuing and future accessibility to the space science, education and general public communities. NSSDC's archive has now grown to 74 TB of space science data and an additional 3.3 TB of Earth science data. During 2008, 27.3 TB of data were added to the NSSDC. That is an enormous increase from last year's 4.2 TB because it includes a 15.5 TB delivery of HEASARC backup data. Even ignoring the HEASARC data, which arrives at irregular, roughly annual intervals, in 2008 we received 8.5 TB of additional data compared with 4.2 TB in 2007.

In 2007 we accepted delivery of the Gravity Probe-B total project archive of 0.54 TB, delivered via RAID. We have defined one dataset so far; the Level 2 data is in preparation for preliminary data distribution. The entirety of GP-B science data are not yet included in the NSSDC statistics, since the ingest procedures for data delivered this way are still evolving.

In 2001 NSSDC began using its reengineered data management approach, which stores data as Archive Information Packages (AIPs; bundles of data files and companion attribute files as prescribed by the ISO/CCSDS Archive Reference model) written to DLTs (to SuperDLTs since 2006). Its first application was for migration of NSSDC Data Archive and Dissemination System (NDADS) data files, which was essentially completed in 2003. About half the AIPs constituent data and attribute files also were written to a unix-based RAID magnetic disk environment for external user access. The IMAGE spacecraft project was the first to use NSSDC-provided software to prepare AIPs for submission to NSSDC and ingestion to the permanent archive. This facilitated an automated NSSDC data ingest and management pipeline, but in practice did not increase efficiency as much as was hoped. Our subsequent approach has been to give to data providers software dubbed X-Man, which allows them to produce a manifest with the most pertinent metadata. The manifest is submitted with the data to NSSDC and packaging into AIPs is done locally. This streamlined method of data archiving has been in use for several months as of this report and has lived up to all our hopes for it; development of the ancillary software to complete a pipeline is in progress.

4. DATA MANAGED AT NSSDC AND 2008 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 datasets and numbers of media volumes managed are also very important. The diversity of datasets and of media types relates to the intellectual and technical heterogeneity of the archive, respectively, and we shall report on these also.

For the remainder of this section we will present this variety of statistics in tables, similar in format to prior years' reports, though recognizing that the content of some tables will not be comparable to those for years earlier than 2005, when our databases were revamped. We intersperse brief discussions, highlighting occasional specifics from individual tables.

Table 1. Counts of NSSDC Datasets on December 31, 2008

Discipline	Digital	Non-Digital	Total
Astronomy	227	78	305
Space/Solar Phys	1226	667	1893
Planetary	700	761	1461
Earth	123	131	254
Other (incl Ephemeris)	99	440	539
Total	2375	2077	4452

By the end of 2008 NSSDC was managing 4,452 distinct datasets and accompanying documentation packages. Table 1 indicates the disciplines from which these datasets come and whether the datasets are digital or non-digital. By dataset count space physics is the dominant discipline, accounting for nearly half of NSSDC's holdings. This reflects 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. The total number of datasets shows a slight decrease from last year, which is an artifact of our on-

going efforts to move data from old magnetic media (e.g. 9-track tapes). Part of the process is to review documentation, disentangle merged datasets and remove duplicate entries; there has been no actual decrease in datasets, but actually a small increase.

NSSDC manages almost as many non-digital (e.g. film, microfilm and microfiche) datasets as digital datasets, though in recent years newly arriving data has been all digital. NSSDC also has generated digital versions for some of its film archive, often in response to requests.

Table 2. State of the NSSDC Archive December 31, 2008

All Digital Data (TB)	
Astrophysics	41.33
Space Physics	25.72
Planetary	6.74
Earth Science	3.30
Other	0.21
Total	77.30

Table 2 is a different characterization of the NSSDC archive, showing byte counts for the entire digital archive. Some of the byte counts, particularly for older media, are estimates, involving assumptions about the mean numbers of bytes on various media types for some datasets. We foresee a shift in coming years with the expected arrival of large planetary datasets. We have received our first large data deliveries from nodes of the Planetary Data System, which are stored temporarily on their transfer media (2 TB data bricks) until they are ingested as AIPs. For more details on NSSDC planning, the NSSDC Archive Plan is available within the NSSDC website.

Table 3. Data Ingested to Nearline Permanent Archive

	2006		2007		2008	
	<i>AIPs</i>	GB	<i>AIPs</i>	GB	<i>AIPs</i>	GB
ALOUETTE	60668	37.26	17151	9.79	17208	9.4231
CDAWEB	3805	769.91	-	-	-	-
IMAGE	1043	16.13	-	-	-	-
ISIS	45344	25.4	133581	67.34	114775	40.4012
LEGACY DATA	-	-	310	2.48	871	6.4014
PDS DATA	-	-	5	62.26	88	288.9524
RHESSI	9826	698.04	8042	574.88	8216	587.0328
SAN MARCO	1790	0.04	-	-	-	-
WIND	361	0.29	332	0.26	346	0.2885
Totals	122,837	1547.08	159,422	717.25	141,504	932.4994

Data are also being moved from NSSDC's traditional offline archive to a near line archive based on DLT and SDLT jukeboxes attached to unix and linux servers, respectively. Data are newly

archived in Archive Information Packages (AIPs), which hold data files and companion attribute files and are media-independent and platform-independent. These are defined 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 portion of the archive for 2006-8; the total of data stored as AIPs has reached 7.7 TB.

About half of the data stored in AIPs are made network-accessible from NSSDC for the convenience of some portions of the user community. Table 4 (below) lists by project NSSDC's network-accessible Space Physics data as of 31 December 2008.

Table 4. Space Physics Data FTP Accessible from NSSDC on December 31, 2008

Top Level Dir	GB
ACE	43.787
CRRES	34.061
DE	186.641
DIRBE	19.963
GEOTAIL	2.924
HELIOS	2.323
IMAGE	260.995
IMP	36.080
ISEE	17.082
ISIS	201.819
MAGSAT	1.869
OGO	1.527
OMNI	19.345
PIONEER	1.905
SAMPEX	54.070
ULYSSES	239.465
VOYAGER	14.518
WIND	27.729
Others*	5.081
TOTAL	1171.184
* total for spacecraft with <1Gb data each, including AE-C,-D,-E, Alouette, Apollo, ARCAD, Cassini, DMR, Explorers 22 and 31, Galileo, Genesis, Hinotori, Mariner 10, Prognoz 6,7, and 9, San Marco, SNOE, and additional Soviet spacecraft.	

Table 5 characterizes the digital media types managed at NSSDC, not including backup copies. It should be noted that most volumes are replicable and have one backup volume. The majority of the Earth Science tapes are in transition to NASA's Earth Science archive and will be released from NSSDC in early 2009.

Table 5. Counts of Volumes* at NSSDC Archive on Dec 31, 2008

	Astro Physics	Space Physics	Planetary Science	Earth Science	TOTAL
4-mm Tape	498	94	3	97	692
8-mm Tape	189	503	74		766
9-Track Tape	531	4743	3721	17290	26285
3480 Cartridges	491	1940	1126	2707	6264
DLT	72	188	2		262
SDLT		7			7
CD	850	22781	5346	54	29031
DVD	969	1092	255	0	2316
12" Worm		4			4
M-O Disk	274				274
LTO-4	35				35
TOTAL	3909	31352	10527	20148	65936

* Backup volumes and those not attributable to these 4 disciplines are not included.

Table 6. Analog Data Products at NSSDC by Discipline

Discipline	Microfilm (reels)	Microfiche (cards)	Film (ft)	Film (frames)	Movie (reels)	Maps	Slides
Astrophysics	2357	5963	100	11975	0	0	62
Earth Science	55	773	13067	64610	4	0	0
Planetary Science	2188	13492	409081	335053	181	1773	768
Space Physics	34589	30507	580	6173	2	0	36893
Other	3224	3624	3785	6206	20	0	2112
Totals	42,413	54,359	426,613	424,017	207	1773	39,835

Table 6 lists NSSDC's analog archive holdings by disciplines and by form factor. The film and movie counts are based on the inventory of the photo materials in 2007. Movie reels had not been called out separately in previous reports, now they are. Film (feet) are reels of uncut film containing sequences of still photos, so for the present time have been inventoried that way. Also we removed from the inventory any backup copies of images, which had notably increased previously reported numbers. In 2008 we completed an inventory of the microfilm and microfiche portions of the analog archive. Both counts increased by more than 30%, which apparently comes from updating less accurate earlier estimates with actual counts. These changes give the most accurate inventory of the analog archive, but, given the changes, the numbers in those columns are not comparable to reports for previous years. We acknowledge a slight over-counting of reels of microfilm, since a few of them contain data from more than one discipline, thus are double-counted. We have included in this year's table the NSSDC map collection of lunar and planetary surface maps, which also were inventoried in 2008. The slides were the last analog component to be inventoried anew; the numbers show a slightly reduced total from previous lists, which likely contained some duplicates..

4.1 Data Inflow

Table 7. Media Arriving at NSSDC During 2008*

	Astro Physics	Space Physics	Planetary Science	Total
4-mm Tapes	69	0	0	69
SDLTs	-77	0	0	-77
CDs	0	613	2	615
DVDs	216	164	0	379
LTO-4	35	0	0	35
Totals	243	777	2	1022

* Ephemeris and Other data not included.

Table 7 characterizes the in-flowing media types by discipline. As in recent years, CDs continued as the dominate input media type received. The LTO-4 tapes are the HEASARC backup data. They replaced the previous HEASARC SLDTs, which were removed from the archive, thus the negative entry. A similar adjustment was made in Table 8, so that the GB of HEASARC data are the net increase within NSSDC.

Table 8. Data Arriving at NSSDC During 2008

Astrophysics	GB	Planetary	GB	Space Physics	GB
FUSE	803.08	PDS	289.73	ACE	27.95
GALEX	4561.99			Alouette	9.42
HEASARC	15498.42			FAST	489.12
FERMI	1600.00			Geotail	3.77
				ISIS	40.40
		Misc		Polar	9.28
		<u>Legacy Data</u>	<u>6.40</u>	RHESSI	587.03
				Twins	2.67
				Ulysses	13.45
				Wind	37.53
Sub-Totals	22463.49		296.13		1220.61
		GRAND TOTAL	23980.24		

Table 8 shows by project the data volumes that NSSDC received in 2008, approximately 24 TB of new data via a combination of electronic deliveries and on media. Dominating the statistics are HEASARC within Astrophysics and both RHESSI and FAST within Space Physics. In coming years we expect the largest data deliveries from Planetary missions.

4.2 Data Outflow

Much of the data outflow discussed in NSSDC Annual Reports before 2003 was activity within SPDF, which maintains the Active Archive for NASA Space Physics missions. Recognizing this distinction, the activities of CDAWeb, etc, now are covered in SPDF reports elsewhere. The Geophysical Models & Services, reported as Table 9 for 2003-2006, moved to the Community Coordinated Modeling Center in 2007, so those activities are also now reported elsewhere.

NSSDC provides user access to its data holdings with network-accessible data for chosen datasets 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 special WWW-based interfaces to specific datasets or groups thereof and ftp pathways to a range of data files maintained permanently on NSSDC disks. The CDF-formatted data underlying CDAWeb are at <ftp://cdaweb.gsfc.nasa.gov/> while all other data are at <ftp://nssdcftp.gsfc.nasa.gov/>. Because NSSDC and SPDF have been and are still co-located at NASA's Goddard Space Flight Center, nssdcftp is and remains a shared resource.

A great many NSSDC datasets and other information services are held permanently on disk for ftp access. The reader is invited to review all these services from the ftp link on the NSSDC home page. Table 9 (below) gives the annual counts of files downloaded, both overall and for selected directories with high activity. Downloading by researchers via ftp of data files from the spacecraft_data subdirectory remained dominant in 2008, showing the high interest in and great value of these services provided by NSSDC and SPDF on this shared resource. The Photo Gallery also remains of high public interest.

Table 9. Number of Files Downloaded via FTP

	2004	2005	2006	2007	2008
Photo Gallery	1,277,133	1,190,555	936,039	720,213	481,089
Spacecraft Data	468,580	1,154,900	802,438	689,961	1,856,362
All others on nssdcftp	813,537	1,263,719	998,388	930,342	634,070
TOTAL	2,559,250	3,609,174	2,736,865	2,340,516	2,971,521

WWW access statistics are frequently misleading, insofar as they usually individually count the many files (buttons, etc.) that make up a page. Nevertheless, WWW accesses are indicative of the continuing use of the WWW-provided NSSDC services. In 2008 there was an average of 9.6M monthly error-free accesses to NSSDC's web pages, slightly higher than 8.7M for 2007. Total web hits averaged 10.8M per month, also an increase from 9.7M per month for 2007.

Table 10. NSSDC User Community (Offline Requests Only) for CY 2008

Affiliation Category	Total Requests	Percent
No Affiliation [General Public]	30	32%
Non_US	15	16%
US Academic Institutions	20	21%
NASA/GSFC	18	19%
NASA Centers, Excluding GSFC	9	10%
Other Government Agencies	1	1%
Miscellaneous	1	1%
Total	94	100.00%

NSSDC responded to 88 (compared to 130 in 2006) distinct requests for ftp data and for “traditional” products. Table 11 characterizes the user community of requestors. 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.

Table 11. Number of Requests for Offline Data by Discipline

DISCIPLINE	Data Set Requests	Data Set Requests
	1968 - 2008	2008
Astrophysics	11455	8
Earth Science	7152	1
Planetary Science	47556	66
Space & Solar Physics	9165	13
Ephemeris	97	0
Other	43	0
TOTAL	75468	88

Table 11 gives the counts of requests for offline datasets from various disciplines in 2008, and as integrated over NSSDC's history. 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 number of requests is slightly larger than in Table 11 because some requests are for data/items related to more than one discipline, so are double counted.

NSSDC has encouraged electronic dissemination to all users whenever possible in recent years. In 2008 ftp distribution was a necessity for most requests due to budget limitations for most of the year, though some media was distributed. Beginning in 2005 NSSDC began tracking data requests by "items" within four broad categories defined in the Notes below. Table 12a shows

the distribution of data served within these categories for 2008 and the previous two years; Table 12b shows the distribution of the items by discipline for the same years. Both Tables 12a and 12b allow us to show ftp as the dominant mode of distribution, even though these statistics include only ftp data that were newly posted in response to a request, not previously available.

Tables 12a,b. NSSDC Offline Data Dissemination Statistics 2005-2008

ITEMS	2006	2007	2008
DISCs	872	441	186
PRINTED	534	177	109
OTHER	119	9	4
FTP	14318	20907	20877
TOTAL	15843	21534	21176

DISCIPLINE	2006	2007	2008
Astrophysics	4395	277	95
Planetary	3401	2311	20979
Space Physics	8040	18946	102
Other	7	0	0
TOTAL	15843	21534	21176

NOTES:

DISCs include CDs & DVDs

PRINTED materials include Photos, Posters, Maps, Documents

OTHER media include Microfilm, Microfiche, Tapes, Videos

FTP include Data, Documents, & Photos posted for FTP download, not files already posted

5. ADDITIONAL NSSDC SERVICES

In addition to its archive of scientific data and the variety of data interfaces characterized in the preceding sections, NSSDC offers a number of additional services, which are described below.

5.1 NSSDC Information Management System (NIMS)

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 has a long term goal of incorporating its off-line data inventory system into NIMS, a major effort for this is underway.

NIMS identifies virtually all launched spacecraft, the experiments carried by many of these spacecraft, and datasets 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. Table 13 details the pertinent NIMS database statistics for 2008.

Table 13. NIMS/JEDS Database Statistics for CY 2008

Subpartition	Number of Records as of 12/31/08	Number Added in 2008
Spacecraft	6438	98
Experiment	5372	33
Dataset	5348	58
Totals	17,158	189

Number of spacecraft with experiment records - 1,058

Number of experiments with datasets at NSSDC - 1,567

Additional datasets associated only with spacecraft, not experiments - 639

Additional datasets that are not associated with spacecraft/experiment - 231

5.2 SPASE

Our efforts continue as a participant in the development of the Space Physics Archive Search & Exchange (SPASE), the dictionary which will be the common language among space physics archives as we move into the age of VOs. Version (1.3.2) of the SPASE Data Model was released on Oct 15, 2008. Previously NSSDC had made available its databases as the source of information and identifiers for SPASE data descriptions for observatories (spacecraft) and instruments (experiments). In 2008 we began development of an enhanced registry interface that will allow better human interaction with the information and produce more meaningful output to be used in the forthcoming releases of SPASE registry software. More information can be found at <http://www.spase-group.org/> which also has a link from NSSDC through its VO Portal.

5.3 Consultative Committee for Space Science Data Systems (CCSDS)

The NSSDC continues to lead within the Consultative Committee for Space Data Systems (CCSDS) for the widespread adoption of the 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. 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. Its use has been considered by an ever growing variety of organizations including data centers, libraries, national archives, and commercial organizations around the world. The reader is referred to <http://www.ccsds.org/> for specifics.

5.4 Virtual Observatories (VOs)

As the designated permanent archive for the Office of Space Science (OSS), with over 30 years experience in managing and preserving digital information comprising thousands of datasets, NSSDC is acutely aware of the need to acquire and preserve data and adequate documentation to ensure they are independently understandable and usable for current and future researchers. This

remains our primary mission. But in this era of Virtual Observatory concepts for more seamless access to data, NSSDC must also play a larger role, especially for data not available from Active Archives. NSSDC will continue to expend considerable effort becoming part of the Virtual Observatories.

5.5 Sun-Earth Connection Education Forum (SECEF)

In 2008 the NASA Sun-Earth Connection Education Forum (SECEF) team, with major NSSDC participation, prepared for and orchestrated Sun-Earth Day 2008 with the theme "Space Weather Around the World" for the main event on March 20. Many thousands packets of information were sent to teachers, scientists and others for Sun-Earth Day programs, reaching hundreds of thousands of people with live webcasts and podcasts. Other events were conducted to coincide with the total solar eclipse on August 1st in China. SECEF also sponsored a number of workshops and teacher professional development events reaching thousands of teachers, amateur astronomers, and the general public in partnership with Heliophysics missions, museums, science centers, and planetariums as well as science and educational professional societies. The SECEF web site for Sun-Earth Day is at <http://sunearth.gsfc.nasa.gov/> .

Glossary

ACE	Advanced Composition Explorer
AE	Atmospheric Explorer
AIP	Archive Information Package
ARCAD	Arc Aurorale et Densite
CCSDS	Consultative Committee for Space Data Systems
CDAWeb	Coordinated Data Analysis Web
CDF	Common Data Format
CRRES	Chemical Release and Radiation Effects Satellite
DE	Dynamics Explorer
DIRBE	Diffuse Infrared Background Experiment
DLT	Digital Linear Tape
DMR	Differential Microwave Radiometers
DVD	Digital Versatile Disk (originally, V = video)
FAST	Fast Auroral Snapshot
FTP	File Transfer Protocol
GB	Gigabyte
GP-B	Gravity Probe-B
GSFC	Goddard Space Flight Center
HEASARC	High Energy Astrophysics Science Archive Research Center
IMAGE	Imager for Magnetopause-to-Aurora Global Exploration
IMP	Interplanetary Monitoring Platform
ISEE	International Sun-Earth Explorer
ISIS	International Satellite for Ionosphere Studies
ISO	International Organization for Standardization
JEDS	Java Experiments, Datasets, Spacecraft
MAGSAT	MAGnetic field SATellite
M-O	Magneto-optic
NDADS	NSSDC Data Archive and Distribution System
NIMS	NSSDC Information Management System
NMC	NSSDC Master Catalog
NSSDC	National Space Science Data Center
NUG	NSSDC User Group
OAIS	Open Archival Information System
OGO	Orbiting Geophysical Observatories
OMNI	Interplanetary Medium Data (not an acronym)
OSS	Office of Space Science
RAID	Redundant Array of Independent Disks (or I = "Inexpensive")
RHESSI	Reuven Ramaty High Energy Solar Spectroscopic Imager
SAMPEX	Solar Anomalous and Magnetospheric Particle Explorer
SDLT	Super DLT (see above)
SECEF	Sun Earth Connection Education Forum
SNOE	Student Nitrogen Oxide Explorer
SPASE	Space Physics Archive Search & Exchange
SPDF	Space Physics Data Facility
TB	Terabyte
VO	Virtual Observatory
WORM	Write-Once, Read-Many