NSSDC/WDC-A-R&S 93-39

1992
ANNUAL STATISTICS AND HIGHLIGHTS REPORT

Joseph H. King
National Space Science Data Center
Greenbelt, Maryland 20771

PREFACE

This is a newly formatted report on the National Space Science Data Center (NSSDC) highlights and statistics for 1992. It consolidates for the first time the material in similarly named documents issued by NSSDC over the past few years and the material in the less widely distributed but more detailed NSSDC annual statistics reports generated over many past years.

The format and content of this report may be transitional in that we hope to receive comments from both the NASA science community and the NASA discipline and program management communities on changes to this report that would make it more useful. Readers, please relay any such comments to me.

During 1992 NSSDC experienced a major reorganization, a transition from being an element of Goddard's Earth Sciences Directorate's Space Data and Computing Division to being an element of the newly created Space Science Data Operations Office (SSDOO) of Goddard's Space Sciences Directorate. NSSDC's former director, James Green, became chief of the SSDOO.

At the same time, NSSDC was issued a new charter statement by the subsequently dissolved NASA Office of Space Science and Applications (OSSA). This charter reflects NSSDC's roles in managing data in support of OSSA Discipline Divisions' data management responsibilities, managing information about increasingly distributed NASA-relevant data, and providing advice and support to the NASA data management endeavor regarding standards and technologies.

Various relations between NSSDC and each of the six formerly OSSA science divisions, now distributed across three OSSA-level offices at NASA/Headquarters, are now emerging.

In parallel to the NSSDC charter, this report is organized around NSSDC-managed data, information about NSSDC data and other data (and about other entities), and other NSSDC activities. We are very pleased with the 1992 results reported herein and will continue to strive to be ever more useful to the NASA research community and to others in need of access to public data from NASA spaceflight missions.

I remain receptive to comments from you on how the nature and quality of NSSDC services and of this report may be improved.

Joseph H. King
Director, National Space Science Data Center

CONTENTS

I.

DATA MANAGEMENT AND DISSEMINATION AT NSSDC

1.0 Data Management and Dissemination at NSSDC

This section is separated into parts addressing the building and management of the archive, and the dissemination of data from the archive.

1.1 Building and Managing the Data Archive at NSSDC

During 1992 NSSDC brought many data into its archive, made many newly arriving data and some previously archived data electronically accessible, and migrated some archived data from old to new media. These three activities are separately addressed in the following subsections.

1.1.1 The Data Archive at NSSDC

During 1992 NSSDC added data from 27 distinct NASA missions in the fields of astrophysics, space plasma and solar physics, planetary science, and Earth science. Highlights included 20 12" optical disks from multiple Dynamics Explorer (DE) investigators, a continuing flow of International Ultraviolet Explorer (IUE) data, 59 CD-ROM titles (many copies each) of Venus radar image data from Magellan, and 1,384 new Nimbus 7 tapes of ozone and other Earth science data sets. Table 1 shows the digital archive at NSSDC grouped by major discipline as of the end of 1992 as well as the data influx during 1992. (See page 4.)

Table 2 shows the data received at NSSDC in 1992 in another representation relative to Table 1. (See page 5.) The "Other" column adds information about analog data ingest to NSSDC. These analog data range from Magellan images to ISEE 1 plasma spectrograms on 35-mm slides. The overall analog data holdings at NSSDC at the end of 1992 are characterized by discipline in Table 3. (See page 6.)

Total counts of data volumes at NSSDC at the end of 1992 are given in Table 4. (See page 7.) Note that these total counts include both primary and backup copies of data, whereas the counts of the previous tables relate to primary copies only.

Yet another discipline-oriented characterization of the NSSDC data archive is Table 5, which shows the total numbers of spaceflight experiments with data at NSSDC. (See page 8.) Note that NSSDC held data from 1,112 such experiments, mostly but not totally from NASA missions. More than half of these are space/solar physics, a discipline area in which NASA flew many multi-instrumented spacecraft in its early years.

1.1.2 Bringing Data to Electronic Accessibility

In order to facilitate an increasingly networked customer community, NSSDC accelerated its migration of data to electronic accessibility. NSSDC presently holds a modest amount of data on magnetic disk (on line) and a large and growing amount on its optical disk jukeboxes (near line). NSSDC presently offers three electronic interfaces to various subsets of its archive.

The NSSDC On-Line Data and Information System (NODIS) account offers data set specific interfaces to two very high-interest, modest volume data sets, namely, the 1963-1991 hourly solar wind data of OMNI and the most recent year of Nimbus 7 daily gridded ozone densities. Appendix 1 gives an overview of the multiple NODIS data and information options.

Selected additional data sets are held permanently on line for File Transfer Protocol (FTP) access via an ANONYMOUS account. These include hourly solar wind data from several heliospheric missions, the "COHO" data base, a large fraction of which was brought on line in 1992. (High interest COBE data were made similarly FTP-accessible in 1993.)

Finally, NDADS, the NSSDC Data Archive and Distribution Service, makes many more data available than NODIS or FTP-access to the permanently on-line data. NDADS is a pair of jukeboxes holding 12" Write-Once, Read-Many (WORM) optical disks. NDADS has a total capacity of 1.2 TB; actual holdings grew from 120 GB to 270 GB in 1992. Table 6 shows annual amounts of data ingested to NDADS during 1990-1992, separated for astrophysics and space physics missions. (See page 8.)

Table 7 characterizes NSSDC's primary electronically accessible data holdings at the end of 1992 and also shows the amounts of data ingested to NDADS during 1992, by mission. (See page 9.)

PRIMARY DIGITAL DATA VOLUMES AT NSSDC AS OF DECEMBER 31, 1992

DISCIPLINE / MISSION	TOTAL VOLUME COUNTS			VOLUMES RECEIVED IN 1992		
	9-Track Tapes	Other Media	Media Type	9-Track Tapes	Other Media	Media Type
ASTROPHYSICS						
ASTRO-C	2			2		
HEAO 2	23	15	CD		15	CD
		8	OD		8	OD
IRAS	278	5	CD	2	4	CD
					40	8 mm
IUE	1,719			76	3	
ROSAT		1	GB (Net)			GB (Net)
San Marco D/L	1			1		
Skylab	1,723	1	Floppy		1	Floppy
VELAS8	36	2	OD	36	2	OD
Yohkoh		1	Floppy		1	Floppy
Other	4,310	1	Floppy			Floppy
TOTALS	7,814	20	CD	117	19	CD
		10	OD		10	OD
		3	Floppy		2	Floppy
					40	8 mm
SPACE PHYSICS						
DE 1	9	11	OD		8	OD
DE 2	21	26	OD	3	12	OD
		1	Floppy			
IMP-J	2,135			39		
ISEE 1	749	10	OD	16	9	OD
ISEE 3	191			11		
Other	14,275	1	Floppy			
TOTALS	17,380	47	OD	69	29	OD
		2	Floppy			
PLANETARY						
Galileo		5	CD		5	CD
Magellan		87	CD		59	CD
Pioneer 10	346			24		
Pioneer 11	373			17		
Pioneer Venus 1	442			21		
Viking 1 Orbiter	493	31	CD		18	CD
Viking 2 Orbiter	240	27	CD		18	CD
Voyager 2	562	12	CD	2		
Other	5,070	5	CD			
TOTALS	7,826	167	CD	64	100	CD
EARTH SCIENCE						
ERBS	354	305	OD	25	52	OD
Nimbus 7	15,380	7	CD	1,384	5	CD
		1	OD			
		34	Floppy			
NOAA 9	120	1	CD		1	CD
		103	OD			
NOAA 10		204	OD		59	OD
NOAA 11		1	CD		1	CD
Other	37,735					
TOTALS	53,589	9	CD	1,409	7	CD
		613	OD		111	OD
		34	Floppy			

Table 1. Data volumes held at NSSDC at the end of 1992 and received during 1992 by mission, grouped by discipline. Counts of backup copies are not included. In virtually all cases, "OD" refers to Write-Once, Read-Many (WORM) optical disks. Pioneer 10 and 11 and Voyager 1 and 2 provided both space physics and planetary data but are fully accounted for under planetary. Space physics includes solar physics. Counts of volumes received at NSSDC during 1992 do not include volumes created at NSSDC.

1.1.3 Data Restoration at NSSDC

As a key element in its assurance of future accessibility of data in its archives, NSSDC continued its program of migrating data from old 7-track and 9-track tapes to new media pairs (9-track tape and 3480 tape cartridges). Table 8 shows the number of tapes input to the program over its five-year life and the number handled in 1992, by discipline. (See page 10.) Over the past five years, a total of 3,850 output media pairs was generated from the 23,754 tapes input. The center is very pleased that in working with data tapes holding ten to thirty years old, the center has been able to migrate over 98% of all the data addressed. In pursuing this program, NSSDC has been guided by community

DATA INGEST 1992

SPACECRAFT	TAPES			OPTICAL DISKS		CD-ROMS	OTHER	ANALOG
	9-Track	8 mm	4 mm	Optimem	Sony			
ASTRO 1								100
ASTRO-C	2							
DE 1				8				
DE 2	3			12				
ERBS	25			52				
Galileo						1		
HEAO 2					8	15		
IMP-J	39							382
IRAS	2	40				4		
ISEE 1	16			9				740
ISEE 3	11							
IUE	76							
Magellan						59		801
Nimbus 7	1384					5		
NOAA 9						1		
NOAA 11								477
Pioneer 10	24							
Pioneer 11	17							
Pioneer Venus 1	21							
ROSAT							3**	
San Marco D/L	2							
Skylab							1*	
SPOT 2								1
Topex/Poseidon								3
VELA 5B	36				2			
Viking 1, Orbiter						18		
Viking 2, Orbiter						18		
Voyager 2	2							
Yohkoh							1*	

* Floppies ** Network, in GB

Table 2. Data Ingest

PHOTOGRAPHIC DATA PRODUCTS AT NSSDC BY DISCIPLINE

DISCIPLINE	MICRO-FILM	MICRO-FICHE	FILM (Feet)	FILM (Frames)	REELS	SLIDES	OTHER
Astrophysics	6,020	18,524	100	63,459		89	
Earth Science	1,430		4,200	236,034	1		
Planetary Science	3,294	6,301	142,814	390,215	259	5	10
Space Physics	20,180	11,588	4,640	4,314		40,790	28
Communications	183						
Other	162						
Total	31,269	36,413	151,754	694,022	260	40,884	38

Table 3. Photographic Data Products Listed by Discipline

prioritizations of data sets, as detailed in the Summer 1993 *NSSDC News*.

1.2 Disseminating Data from NSSDC

NSSDC disseminates many data, both electronically and via off-line mailings of data volumes. This section is separated into subsections addressing these two distinct modes. In most cases of electronic dissemination, there is no NSSDC staff involvement. In the subsections below, the NSSDC is able to characterize better its off-line users since information about off-line requesters is captured into an information base. Such information is impractical to capture where users are accessing data electronically, so the amount of E-access activity to on-line and near-line files is taken as the measure of their value.

1.2.1 Electronic Data Access

During 1992 NSSDC witnessed an explosive growth in the electronic dissemination of data. The numbers of accesses to the various NODIS data files during 1992 are given in Appendix 1. (See Page 31.) Finally, the numbers of accesses, and separately, the numbers of files downloaded, by NDADS users are given in Table 9, by mission. (See Page 10.) For comparison, the equivalent numbers for 1991 are also shown in Table 10. (See Page 11.) Note that, summed over the NODIS and NDADS access paths, the number of electronic accesses to NSSDC data increased from 23,786 to 43,133 between 1991 and 1992. Most of this gain was due to the increased accessibility of high interest data on NDADS. NSSDC is very pleased with this increase.

1.2.2 Off-Line Data Access

During 1992 NSSDC satisfied 4,819 distinct requests for data. About 40% of these were for source catalogs from NSSDC's Astronomical Data Center. Table 11 lists the most frequently requested data sets, in order of their request numbers. (See pages 11 and 12.) Note the multi-disciplinary character of the data sets high on this list. The

VOLUME OF DATA AT NSSDC BY STORAGE MEDIUM

STORAGE MEDIUM	VOLUME AS OF DECEMBER 31, 1992	INCREASE SINCE DECEMBER 31, 1991
Digital Magnetic Tape:		
1/2 in. x 2400 ft.	108,432	2,383
8 mm	44	44
3480	2,014	2,014
CD-ROM (Titles)	234	184
Optical Disk:		
Optimem	28	28
Sony (managed)	0	0
Floppy Disk	64	5
Video Tape	9	6
Microfilm, 100-ft. Reels	39,118	10
Microfiche	45,542	54
Photographic Film:		
5-in. width, linear ft.	174,578	0
9.5-in. width, linear ft.	268,078	0
70-mm width, linear ft.	590,219	100
35-mm width, linear ft.	707,852	0
16-mm width, linear ft.	353,341	0
70-mm width, each	752	0
4x5 in., each	21,401	29
5x5 in., each	1,181	0
5x7 in., each	874	0
5x12 in., each	4,045	0
8x10 in., each	68,878	1,229
11x14 in., each	52	0
12x15.5 in., each	8	0
16x20 in., each	95	0
20x24 in., each	8,264	0
2.25x2.25 in., each	36,713	740

Table 4. Total counts of volumes by type in the NSSDC archive as of the end of 1992 and changes relative to the previous year. For Sony platters this includes NDADS mounted platters. For round tapes the "increase" represents new tapes submitted less a net diminution associated with NSSDC's data restoration program. (See section 1.1.3.)

NUMBER OF EXPERIMENTS BY DISCIPLINE/ SUBDISCIPLINE WITH DATA ARCHIVED AT NSSDC THROUGH 1992

DISCIPLINE	EXPERIMENTS WITH DATA	EXPERIMENTS WITH FIRST DATA SET RECIEVED IN 1992
Astrophysics	103	6
Space Physics	612	0
Planetary	263	2
Earth Sciences	117	4
Life Sciences	4	0
Other	13	0
TOTAL	1,112	12

Table 5. Experiments with Data by Discipline

NEAR-LINE INGEST 1989 - 1992

YEAR	ASTROPHYSICS	SPACE PHYSICS	TOTAL
1989	0.39 GB	0.00 GB	0.39 GB
1990	41.43 GB	5.60 GB	47.03 GB
1991	71.60 GB	4.35 GB	75.95 GB
1992	128.63 GB	16.57 GB	145.20 GB
TOTALS	242.05 GB	26.52 GB	268.57 GB

Table 6. NDADS Ingest Annual Rates by Discipline

planetary data and many other top-ranked data sets were largely sent out on CD-ROMs. Table 12 shows the numbers of data requests satisfied by NSSDC in 1992 and over its lifetime. (See page 13.) Planetary requests dominate owing to the popularity of lunar and planetary images. There is a remarkable balance across the other NSSDC-supported disciplines over the years.

Table 13 shows the numbers of media types mailed by NSSDC in 1992. (See page 13.) Note that, at 600+ MB/CD-ROM, over 10 TB of data were

DATA ELECTRONICALLY ACCESSIBLE FROM NSSDC AS OF DECEMBER 31, 1992

	TOTAL VOLUME AS OF DECEMBER 31, 1992 (# OF MBYTES)		(# OF MBYTES) MADE ELECTRONICALLY ACCESSIBLE IN 1992	
Mission	On-Line	Near-Line	On-Line	Near-Line
ACTIVE	3		1	
ADC		4,390		1,400
COHO**	**	**	**	**
DE		21,000		10,500
GINGA		826		389
HEAO 2		4,071		571
HEAO 1		600		600
HEAO 3		604		604
HST		2,600		2,600
IMP 8		6,125		6,110
IRAS		81,500		72,500
ISEE 3		1,430		1,430
ISTP	1			
IUE		136,500		43,250
NIMBUS	16			
OMNI	28		9	
ROSAT		3,100		3,100
SKYLAB		7,350		7,350
STELAR		3,680		3,680
VELA 5B		3,210		
TOTAL	48	276,986	10	151,484

Table 7. Electronically Accessible Data by Mission

disseminated on CD-ROM. Table 14 shows monthly off-line shipping activity levels. (See page 14.) The numbers are dominated by newsletter mailings, but it is noteworthy that ten to twenty actual data shipments leave NSSDC daily. About half (48.1%) NSSDC requests for off-line data are received by

DATA RESTORATION FROM NSSDC CY 1992

DISCIPLINE	OVERALL (THROUGH 1992)	DURING 1992
Astrophysics	744	114
Space Science (and Solar)	8,222	4,053
Planetary (and Lunar)	590	115
Earth Science	14,198	1,809
Totals	23,754	6,091

Table 8. Counts of Restored Tapes

NDADS DATA ACCESS CY 1992

DISCIPLINE	NUMBER OF FILES	REQUESTS
Space Physics		
DE	3,539	79
IMP 8	2,106	134
Skylab	556	81
ISEE 3	6	5
Astrophysics		
IUE	100,966	5,799
Vela 5B	5,764	228
ADC	3,902	668
NRAO	87	70
STELAR	461	76
IRAS	1,305	73
HST	479	10
HEAO 2	29	20
GINGA	28	22
ROSAT	5,609	444
HEASARC	80	10
HEAO 3	3	6
Total	124,920	7,725

Table 9. Data Disseminated from the NSSDC in 1992 Through NDADS

telephone or other oral communication, a third (36.1%) are received electronically, and only a sixth are received via letter or FAX.

Table 15 characterizes the NSSDC off-line data request community. (See page 15.) In addition to continuing its support for the NASA and other U.S. and international research communities, NSSDC is supporting access by the "general public" to NASA data. To a significant extent, this represents getting CD-ROMs into the U.S. educational community.

NDADS DATA ACCESS CY 1991*

DISCIPLINE	NUMBER OF FILES	REQUESTS
Astrophysics		
IUE	3,405	334
VELA 5B	3	7
ADC	25	20
IRAS	1,148	7
HST	0	10
Total	4,581	378

*NDADS was first announced on November 25, 1991.

Table 10. NDADS Data Access for 1991 Reflecting Data Collected from November 25 Through December 31, 1991

DATA MOST FREQUENTLY REQUESTED FROM NSSDC CY 1992

RECORD ID	NAME	COMPLETED REQUESTS
GA-16	Miscellaneous Astronomy Catalogs	841
83-004A-01	IRAS, Infrared Telescope	713
77-076A-01	Voyager 2, Imaging	499
75-075A-01	Viking 1, Orbiter Imaging	436
77-084A-01	Voyager 1, Imaging	385
75-083A-01	Viking 1, Orbiter Imaging	356
89-033B-01	Magellan, Synthetic Aperture Radar	315
78-098A-09	Nimbus 7, SBUV/TOMS-Backscatter UV/Ozone	228
GA-11	Astrometric Data Catalogs	154
GA-12	Astronomy Catalogs Photometric Data	122
GA-13	Astronomy Catalogs Spectroscopic Data	116

Table 11. Data Sets Sorted by Off-Line Request Activity (Table 11 continues on page 13.)

DATA MOST FREQUENTLY REQUESTED FROM NSSDC CY 1992 (Continued)

RECORD ID	NAME	COMPLETED REQUESTS
GA-17	Non-Stellar Objects Astronomy Catalogs	74
NCDS	ISCCP	66
GA-15	Combined Astronomy Catalogs	66
73-027A-05	Skylab, X-Ray Spectrometer Telescope	54
MN-61	Atmospheric Models	52
PG-18	Magnetic Field Retrieval Programs	37
MI-91	Ionospheric Models	33
73-078A-01	IMP-J, Tri-Axis Magnetometer	31
78-098A-03	Nimbus 7, CSCZ-Coastal Zone Color Scan	22
SM-41	OMNITAPE	22
78-079A-02	ISEE 3, Magnetic Fields	21
72-096A-05	Apollo 17A, Handheld Photography	20
67-041A-01	Lunar Orbiter 4, Lunar Photos	19
84-108B-01	ERBS, Earth Radiation Budget Experiment (ERBE)	17
PT-11	Trapped Radiation Programs	17
78-098A-07	Nimbus 7, ERB-Earth Radiation Budget	16
78-079A-01	ISEE 3, Solar Wind Plasma	15
XD-21	Remote Sensing Geological Field Experiment	14
72-031A-01	Apollo 16A, Handheld Photography	13
78-012A-01	IUE, Ultraviolet Spectrograph	13
73-078A-02	IMP-J, Solar Plasma, Faraday Cup	12
71-063A-01	Apollo 15A, Handheld Photography	11
78-103A-02	HEAO 2, High-Resolution Imager	10
78-103A-04	HEAO 2, Imaging Proportional Counter	10
GA-14	Astronomy Catalogs Cross Identification	10
MS-13	Miscellaneous Reference Solar Spectra	10
75-075C-06	Viking 1, Lander Imaging	9
86-073A-05	NOAA 10, Earth Radiation Budget Experiment (ERBE)	9
89-084B-10	Galileo, Solid-State Imaging (SSI)	9
MN-17	Atmospheric Models	8
GX-11	Molecular Lines	8
69-059A-01	Apollo 11, Photos 70, 16, and 35 mm	8
66-100A-01	Lunar Orbiter 2, Lunar Photos	7
77-102A-04	ISEE 1, Fluxgate Magnetometer	7
81-111A-01	STS 2, Shuttle Imaging Radar (SIR-A)	7
84-123A-05	NOAA 9, Earth Radiation Budget Experiment (ERBE)	7
67-075A-01	Lunar Orbiter 5, Lunar Photos	6
70-025A-03	Nimbus 4, IR Interferometer Spectrometer (IRIS)	6
73-078A-10	IMP-J, Plasma, Electrostatic Analyzer	6
75-083C-06	Viking 2, Lander Imaging	6
84-108B-02	ERBS, Stratospheric Aerosol and Gas Experiment/SAGEII	6

Table 11 (Continued)

NUMBER OF REQUESTS FOR SATELLITE DATA FROM NSSDC BY DISCIPLINE

DISCIPLINE	DATA SET REQUESTS 1968 - 1992	OFF-LINE DATA SET REQUESTS 1992
Astrophysics	5,287	871
Earth Science	6,290	605
Planetary Science	21,664	4,288
Space Physics	6,836	201
Ephemeris	50	11
Other	15	0
Total	40,142	5,976

Table 12. Off-Line Request Counts by Discipline

NSSDC REQUESTS OUTPUT BY MEDIUM CY 1992

MEDIUM	REQUESTS COMPLETED	QUANTITY	AVERAGE QUANTITY PER REQUEST	OUTPUT UNIT
Floppy Disks	1,393	1784	1.281	Each Disk
CD-ROM	2,277	18,373	8.069	Each Disc
Books/Bound Volumes	1,324	1,703	1.286	Each Binder
Punched Cards	1	1	1.000	Each Card
Computer Tapes	483	3,358	6.952	2,400-Foot Tape
Negatives (Feet)	3	502	167.333	Each Strip
Microfiche	62	1,471	23.726	Each Plate
Hard Copy	492	7,918	16.093	Each Page
Movie/Kinescope Film	1	389	389.000	Each Roll
Microfilm	3	64	21.333	100-Foot Reel
Microfilm Copies	14	13	0.929	100-Foot Reel
Computer Printout	258	11,278	43.713	Each Page
Slides	16	470	29.375	Each Slide
Transparencies	23	319	13.870	Each Sheet
Photographic Prints	116	4,569	39.388	Each Sheet
Negatives	23	651	28.304	Each Sheet

Table 13. Media Types Mailed in 1992

SHIPPING ACTIVITY CY 1992

MONTH	DOCUMENT SHIPMENTS	DATA SHIPMENTS	TOTAL
January	4,293	352	4,645
February	4,293	304	4,597
March	7,629	340	7,969
April	424	357	781
May	4,115	331	4,446
June	8,185	444	8,629
July	4,147	291	4,438
August	1,998	366	2,364
September	9,738	221	9,959
October	480	256	736
November	9,711	191	9,902
December	5,978	208	6,186
TOTALS	60,991	3,661	64,652

HISTORICAL SUMMARY OF SHIPPING ACTIVITY AT NSSDC (CALENDAR YEAR)

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992
Shipments	16,272	34,740	22,609	27,230	24,137	24,471	22,641	23,085	64,642*

* Increase due to addition of STEP newsletter distribution

Table 14. Shipping Activity

NSSDC USER COMMUNITY CY 1992*

AFFILIATION CATEGORY	PERCENT OF TOTAL
Non-U.S., Excluding Socialist Countries	28.94
U.S. Universities/Colleges	26.03
U.S. Private Industry	11.06
No Affiliation (General Public)	12.79
NASA/GSFC	4.55
Other Government Agencies	8.80
Miscellaneous	1.31
NASA Centers, Excluding GSFC	4.82
Former Socialist Countries	1.70
Total	100.00

* Off-line requests only

Table 15. Vax Community

II.

INFORMATION MANAGEMENT AT NSSDC

2.0 Information Management

NSSDC manages a great deal of information about data, their source spacecraft and instruments, and about other entities identified below. NSSDC's goals are (1) to support data finding and access in an increasingly distributed NASA and international data environment, (2) to support the retrieval and use of NSSDC-held data, and (3) to provide a comprehensive information base on past, present, and future NASA and other missions and their investigations for both the scientific and NASA program management communities.

Meeting the first of these goals has led to the NASA Master Directory, which is further discussed below. Meeting the second has led to various inventory files at NSSDC related to both its off-line and on-line/near-line data holdings discussed in the previous section. These files are critical to smooth NSSDC operation but will not be discribed here. Meeting the third goal led NSSDC years ago to create several files that will be discussed below.

2.1 The NASA Master Directory

The NASA Master Directory (NMD) describes at a very high level NASA-research-relevant NASA and non-NASA data publicly accessible worldwide. It is presently identical to the multi-agency Global Change Master Directory (GCMD), which has formed the basis for the International Directory Network.

The NMD identifies virtually all NSSDC-held data, virtually all the data held at the various NASA discipline-specific data systems (Planetary Data System, Astrophysics Data System, etc.), and a great deal of data held elsewhere both within and beyond the NASA environment.

The basic NMD information unit is packaged in the Directory Interchange Format and is usually called a DIF. DIFs may describe data considered one data set by the data holding site or may describe a great many such data sets through "aggregation." Because of the practice of aggregation, DIF counts are an imperfect measure,

AIM PARTITION STATISTICS FOR CY 1992

SUBPARTITION	NUMBER OF RECORDS AS OF 12/31/92	NUMBER ADDED IN 1992
Spacecraft	4,751	131
Experiment	5,136	239
Data Set	4,902	88
Total	14,781	458

Number of Spacecraft with Experiments Known: 944
Number of Experiments with Data Sets at NSSDC: 1,272

Table 16. AIM Spacecraft, Experiment, and Data Set Records Inserted in 1992

AIM PARTITION BY DISCIPLINE AS OF DECEMBER 31, 1992

DISCIPLINE	SPACECRAFT	EXPERIMENTS	DATA SETS
Astrophysics	224	195	334
Solar Physics	129	206	242
Space Physics	412	1,180	1,455
Planetary	155	566	1,410
Earth Science	418	349	373
Life Science	53	238	5
Microgravity	30	90	0
Other*	1,199	49	13
To Be Identified**	2,604	2,263	1,070
TOTAL	4,571	5,136	4,902

* Includes engineering, communications, human crew, navigation/global positioning, resupply/repair/refurbish, surveillance, or ephemeris

** Includes a great many Soviet COSMOS spacecraft

Table 17. AIM Record Counts by Discipline

although the most readily available measure, of the status of NMD population.

Table 17 reports DIF counts by discipline by data-holding agency, at the end of 1992 and as created and inserted into the NMD during 1992. (See above.) A very small minority of DIFs may be multi-counted.

Principal access to the NMD (and GCMD) has been through NSSDC's NODIS account. During 1991 and 1992 the numbers of user accesses (not including NSSDC staff accesses) were 23,463 and 36,408. These numbers represent approximately 40 daily accesses. A more detailed discussion of the Master Directory and of the companion Catalog Interoperability activity is given in Appendix 2.

2.2 Relational System for Information Retrieval and Storage (RSIRS)

RSIRS has its heritage in NSSDC's long-term information base that, in a pre-relational Data Base

NSD PARTITION STATISTICS AT END OF CY 1992

DISCIPLINE	NUMBER OF DATA SETS
Astrophysics	977
Space Physics	418
Earth Science	61
Planetary	27
Other	18
TOTAL	1,501

Table 18. NSSDC Data Sets by Discipline

Management System (DBMS) environment consisted of a number of hierarchical information files. These files are now the "partitions" of the RSIRS database and consist of the following:

The Automated Internal Management (AIM) File tracks spacecraft, their onboard experiments, and resulting data sets, primarily those archived at NSSDC. Table 16 shows the numbers of these entities tracked in the AIM file. (See page 19.) Table 18 further breaks out these counts by discipline. (See above.)

The NSSDC Supplementary Data (NSD) File tracks non-spacecraft data, multi-source spacecraft or other data, models and programs, Astronomical

TRF PARTITION STATISTICS AS OF DECEMBER 31, 1992

Total Number of Records (Science Papers)	33,902
Number of Records Inserted During 1992	2,130

Table 19. TRF Statistics

Data Center (ADC) source catalogs, and other NSSDC-held data sets that do not fit the AIM spacecraft/experiment/data set hierarchy. Table 18 shows the number of data sets identified in NSDF by discipline. (See page 21.)

The Technical Reference File (TRF) tracks published and some unpublished papers uniquely associated to spaceflight experiments through their unique IDs.

Table 20 shows The Interactive Request Activity and Name Directory (IRAND) statistics. (See Table 20 below.) The IRAND File tracks people and their multiple addresses, which distribution lists they are on, and their individual requests. (Note that IRAND underlies NODIS/PIMS, discussed in Appendix 1.)

Interactive Data Archive (IDA) File tracks scientific rocket launches. Table 21 shows the IDA's statistics as of December 31, 1992. (See Table 21 below.)

IRAND PARTITION STATISTICS AS OF DECEMBER 31, 1992

RECORD TYPE	TOTAL RECORDS	1992 ACTIVITY	
		Records Inserted	Records Updated
Personnel	42,643	2,518	7,449
Request	61,996	4,567	—

Table 20. IRAND Statistics

IDA AND ROCKET STATISTICS AS OF DECEMBER 31, 1992

PARTITION	TOTAL RECORDS	RECORDS INSERTED
IDA	125,920	5,945
Rocket	15,478	36

Table 21. IDA and Rocket Statistics

III.

OTHER NSSDC ACTIVITIES

3.1 NASA/Science Office of Standards and Technology (NOST)

The NASA/Science Office of Standards and Technology (NOST) at the NSSDC was established by the Office of Space Science and Applications (OSSA) at NASA Headquarters to serve the space and Earth science communities in evolving cost-effective, interoperable data systems. It has been recognized that research organizations that promote the use of cost-effective standards for their operations will have relatively more resources available to devote to the generation of truly unique and significant advances in science and technology. To this end, NOST performs a number of functions designed to facilitate the recognition, development, adoption, and use of standards by the science communities.

NOST is organized into four distinct functional areas, all operating under the guidance of its Executive Board. These areas are known as NOST Administration, Standards Library, Standards Development, and Standards Support. (See Figure 1 below.) The administration operation is concerned with managing the activities of the other three NOST areas, administering the office's policies and procedures, and providing an active interface to other standards organizations within and outside NASA to foster both the exchange of standards information and the development of new standards. The Library is concerned with collecting, updating, and disseminating information about existing and emerging standards of relevance to NASA and NASA-related data systems. Information on recognized standards (i.e., standards documented by recognized standards organizations such as the International Standards Organization [ISO], American National Standards Institute [ANSI], and Consultative Committee for Space Data Systems [CCSDS]), and de facto standards (i.e. specifications/systems in wide and stable use) are the primary categories maintained in the library, with each broken into a number of subcategories to facilitate

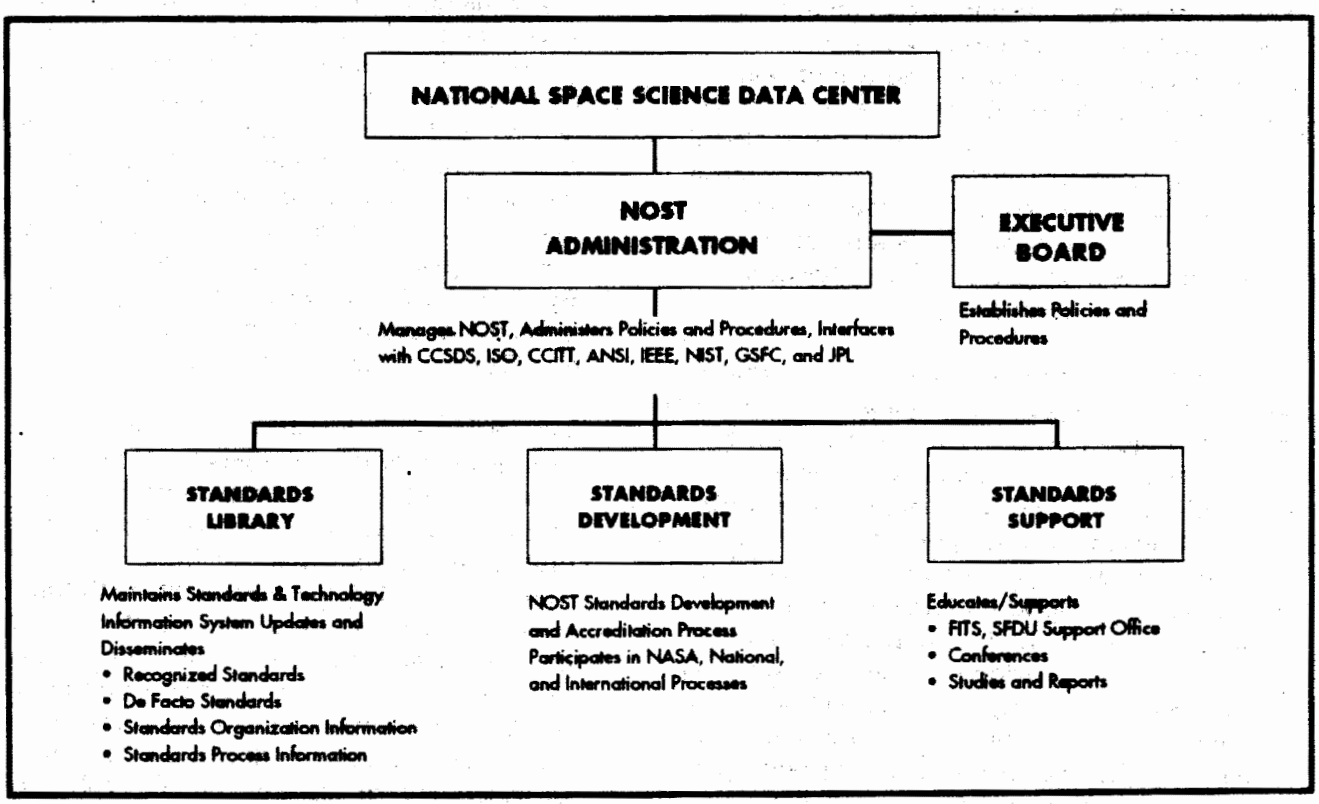

Figure 1. NASA/OSSA Office of Standards and Technology

searching and understanding. Other categories include information on the various standards organizations, on the standards creation process, and on new technologies. Some standards specifications are available on request, while others must be obtained from commercial organizations. Requests for standards information may be satisfied through the Standards and Technology Information System (STIS), an easily used NOST on-line data base and software system. For accessing information on standards and technology, electronic mail to the NSSDC account known as NCF::NOST or nost@nssdca.gsfc.nasa.gov, or use mail request to the NSSDC. The overall library operation, including STIS, provides an educational service to the space and Earth science community.

The Standards Development operation can be viewed as consisting of two parts. One part is concerned with NOST participation in various NASA, national, and international standards development efforts to assist the broader communities in evolving standards beneficial to NASA science needs. Examples included participation in CCSDS and ANSI committees. The second part is concerned with the establishment, maintenance, and use of policies and procedures for the development of new standards and the adoption of existing standards as NOST standards. These policies and procedures cover the establishment of technical panels to develop standards, the review processes through which draft standards must pass, and the logistical support available from NOST.

The Standards Support operation is concerned with support for existing and emerging standards. This support ranges from providing information to potential users on experience with commercial standards and holding workshops in standards-related issues to a full support office for the use of a particular standard. Where a commercial vendor is not available to support a particular standard, testing and validation of an implementation of the standard may be provided by this operation. The actual operations at any one time will depend on the needs of the community and the availability of resources. The overall Standards Support operation provides a broad range of educational and supportive services to the science communities. Using standards is an effective and efficient method for controlling time and dollar costs incurred while performing many functions. Data systems developed using standards are often less expensive to develop and maintain. They are easier to understand and more adaptable to changing requirements. The use of widely acknowledged standards results in users' independence from single vendors, and allows users to produce their data systems with less risk. Often the use of standards is mandated by higher authorities or required by contractual agreements.

The Standards and Technology Information System (STIS) is a centralized electronic library that lets users know about available standards. The STIS is supported by the NASA/Science Office of Standards and Technology (NOST) and is a tool to help NOST accomplish its mission to facilitate the recognition, development, adoption, and use of standards by the NASA science communities. Besides the information on the actual standards and related documents, this library also contains information about emerging technologies where standards may not yet have been developed. This referenced material may have originated from a variety of sources such as books, technical or popular press articles, government or industry reports, and reports created by the NOST staff or NOST technical contributors. NOST encourages individuals within the community who have an interest in a particular standard or new technology area to register as NOST technical contributors. By doing so they agree to provide reports as new information comes to them for incorporation into the STIS under their authorship.

The information displayed for these documents includes standards identifiers (e.g., ISO 9660), title source, publication and copyright data, the names of any identified authors or editors, and the organization responsible for the document. The staff also classifies the documents with topic and content codes, assigns a number of keywords to aid the user in searching for the document and often prepares an abstract or comments on the document. If copyright provisions can be accommodated, the full text of many of the shorter documents is provided. Future implementations of the STIS are

planned to include the display of information needed to order copies of documents directly from the source. At all times the NOST may be contacted for ordering information.

The STIS also contains information on the policies and procedures of the NOST. This provides the user with on-line information regarding NOST functions and services.

The STIS is also able to display information on a number of organizations that are active in the standards development field, including information on the areas in which these organizations are working. Contact points within those organizations are provided for users who need further information.

All the information in the STIS is presented through a series of user-friendly menus. Most users find they can use the system without any help or training. Comments and requests to NOST/STIS may be directly entered by users at virtually any point.

The STIS may be accessed through the NSSDC On-Line Data and Information System (NODIS), which is described elsewhere in this report.

3.2 Common Data Format (CDF)

The Common Data Format (CDF) is a portable scientific data management package that was designed and developed at the NSSDC. The term "CDF" is used synonymously with respect to the data format/files and the software package that produces and exploits them.

The development of CDF arose out of NSSDC's recognition that a class of data models matched to the structure of scientific data as well as to how such data may be used. The software package, known as the CDF Library, allows programmers to access and manage flat and multi-dimensional data in a fashion consistent with the geometry of their scientific orientation. Traditional methods of handling scientific data such as flat sequential files are generally inefficient in storage, access, or ease-of-use for large complex data sets particularly for applications like visualization. Modern, commercial relational data management systems do not offer an effective solution because they are more oriented towards business applications and do not accommodate multi-dimensional or hierarchical structures often found in scientific data sets. In addition, relational systems do not provide adequate performance for the size, complexity, and type of access dictated by current and future data sets and their potential usage.

The CDF Library was designed to provide the essential framework from which generic applications (e.g., visualization, statistical analysis, browsers, etc.) can easily be created. The library allows developers of CDF-based applications to easily create applications that permit users to slice data across multi-dimensional sub-spaces, access entire structures of data, perform sub-sampling of data, and access one element independently regardless of its relationship to any other element.

The hallmark of the CDF concept is its data set independence. This independence is achieved by means of an internal format containing its own data dictionary (metadata) as well as the data themselves. In other words CDF describes its own format. This self-describing property makes it possible for the CDF to be used for data from a wide variety of disciplines. The CDF files contain two types of data, the actual data values (i.e., Reals, Integers, Chars, etc.) themselves and the user-provided metadata. Both the metadata and the actual data are accessible by means of standard software routines known as the CDF Interface, which provide the programmer with an abstract view of the contents of the data within a CDF file.

The CDF software package is used by hundreds from government agencies, universities, private, and commercial organizations as well as independent researchers on both national and international levels. CDF has been adopted by the International Solar-Terrestrial Physics (ISTP) Project Central Data Handling Facilities (CDHF) as their format of choice for storing and distributing key parameter data.

The CDF staff and software were recognized in May of 1993 as part of a GSFC Group Achievement Award for playing an instrumental role in the

CDF USER COMMUNITY

GROUP	NUMBER OF USERS
ISTP-Related Users	Greater than 200
ESA-Related Users	Greater than 300
Others (Government, Universities, Commercial/Private, and Independent Users)	Approximately 100

Table 22. Common Data Format User Community

development of the ISTP CDHF software. In addition, CDF has recently been adopted by the European Space Agency's (ESA) Cluster project for storing and distributing data among ESA and the space physics Intra-Agency Consultative Group (IACG) user community. Table 22 illustrates the primary user groups and an estimate of the number of users that are supported in each. (See above.)

The CDF is now being supported by the Jet Propulsion Laboratory (JPL) Linkwinds visualization software and Research Systems Incorporated (RSI) Interactive Data Language (IDL) analysis package. IDL is a commercial package, is heavily utilized throughout the science community, and has recognized CDF as an instrumental part of that community.

IV.
APPENDICES

A.1 NSSDC On-Line Data and Information Services (NODIS)

A major part of the mission of the NSSDC is disseminating information relevant to NASA data and filling requests for the data from the general community. Several years ago this was done mainly through telephoned and mailed requests, requiring days to months to complete. The NSSDC On-Line Data and Information Service (NODIS) has revolutionized these methods. Now, many of the data and information requests are filled automatically within minutes through NODIS's openly available, network-accessible, general usage interface leading to interconnected information systems. Requests for off-line data have also been made more efficient through the automation of requests. Through NODIS users can access worldwide space and Earth science data information, consult a 40,000-name data base, immediately receive data from selected projects, browse bulletin boards and newsletters, get references on standards, etc. NODIS is the gateway to NSSDC's suite of information systems, and NSSDC's leadership in this type of activity has inspired similar activities throughout the federal and international community. Many of these projects have been interconnected and are also accessible through NODIS.

NODIS takes advantage of and continues to apply research in many state-of-the-art technologies for request fulfillment, such as anonymous FTP, generic access file directories, captive account methodology, automated electronic mailing, relational data base

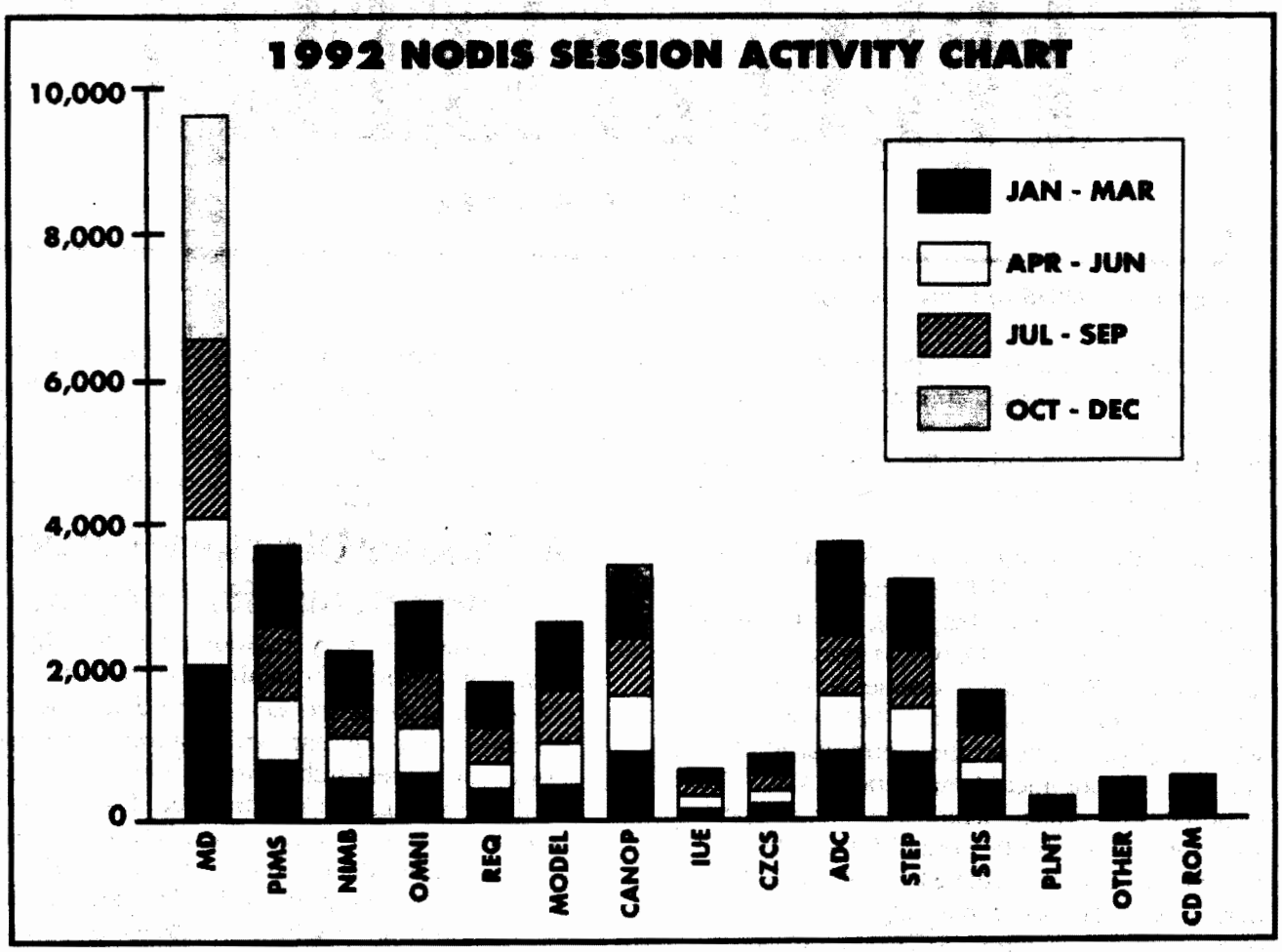

Figure 2. Annual Session Totals for Individual NODIS Services

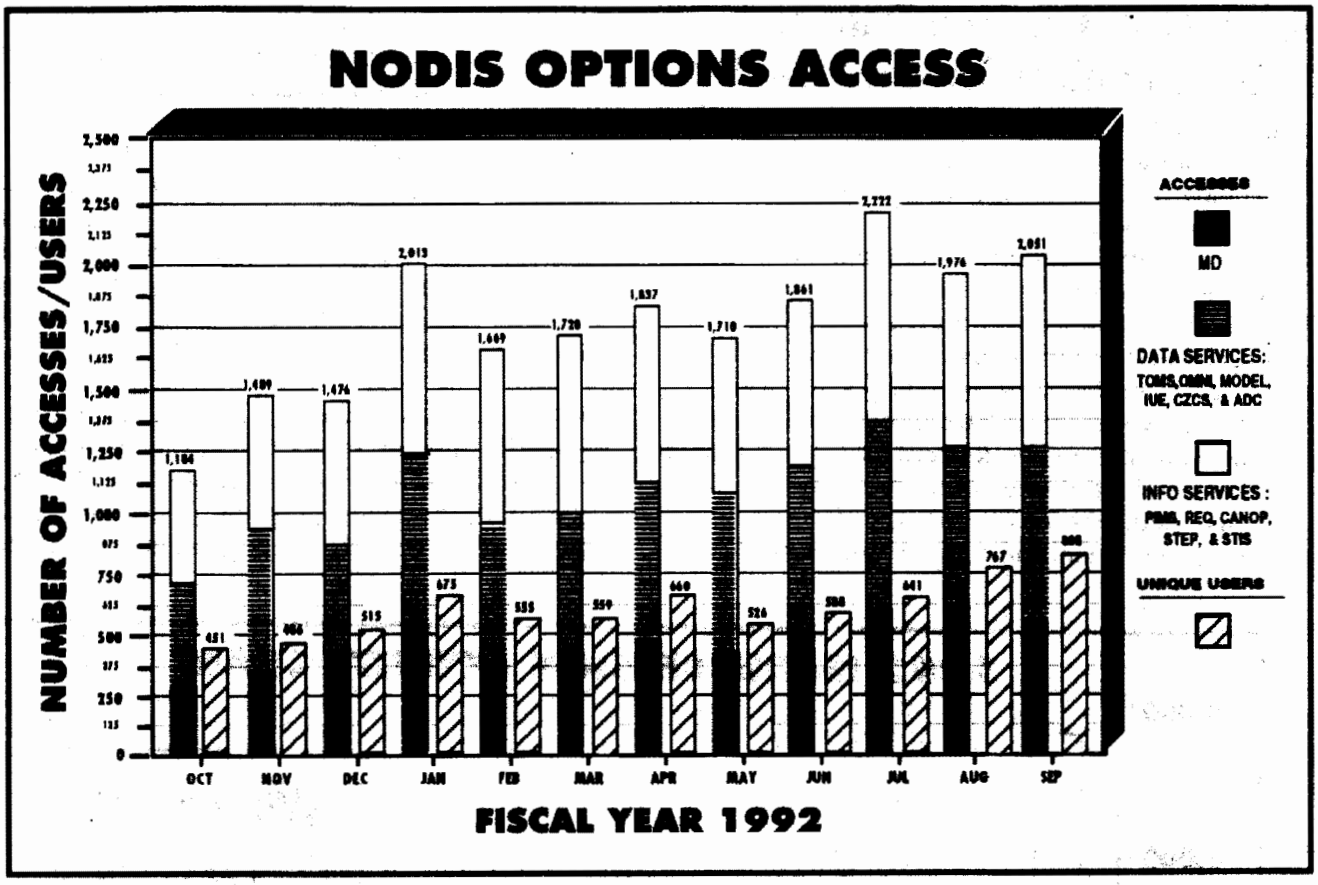

Figure 3. NODIS Options Accesses/Users for 1992

interconnections, mass storage and retrieval systems (optical disk jukeboxes, magnetic disk staging, etc.), data format standards, and so forth. The guiding principle is always to find the best ways within resource limitations to improve service to users.

Data available via NODIS include International Ultraviolet Explorer (IUE) extracted spectra data, Nimbus 7 Total Ozone Mapping Spectrometer (TOMS) Gridded Total Ozone Mapping Spectrometer data, Coastal Zone Color Scanner (CZCS) data, the Interplanetary Medium Data (OMNI) set of hourly solar wind parameters, the Geophysical Models, and the Astronomical Data Center (ADC). The information services include the NASA Master Directory (MD); the Personnel Information Management System (PIMS), an interface to a personnel data base containing over 40,000 users of NSSDC services; the NSSDC Data Request Service (REQ); the American Institute for Aeronautics and Astronautics (AIAA) Canopus newsletter; the Solar-Terrestrial Energy Program (STEP) Bulletin Board Service, the Standards and Technology Information System (STIS); the NASA CD-ROM service; and other on-line services. Figure 3 above shows the annual session totals for each of these services.

A.2 Master Directory/Catalog Interoperability (MD/CI)

The Master Directory at Goddard Space Flight Center was originally established as an aid for NASA-funded researchers to find data. The directory contains brief summary information about data sets, sufficient for researchers to determine whether further investigation is warranted. It also provides automated links to other information systems that give more detail on data sets of interest (guides) or on the parts of the data sets (inventories), or an indication of whom to talk to for additional information. The directory serves its purpose well, and other agencies and international organizations

have been given copies of the directory software to perform the same function within their groups. These directories have been interconnected via computer network to enable information sharing to the benefit of all. In addition, the directory at Goddard Space Flight Center has been requested to serve as the centralized Global Change Master Directory for describing the global change data holdings of the U.S. federal agencies.

The directories represent the most widely-used part of the interoperable data information system. This is evident from their ever-increasing usage. The Master Directory at GSFC has been operational for four years, and present usage is approaching 10,000 user sessions per year at the GSFC node. Since the directory is intended to provide quick information to users and lead them to actual data sources, wherever they may be, the users do not need many sessions to obtain results. Thus, several thousand users were accommodated by the Goddard node during last year.

Not just data sets are described in the directory. There is also supplementary information about other data information systems and data archives, organized data collecting campaigns and projects, data sources such as spacecraft or Earth-based observing platforms, and data sensors used to acquire the data. The number of data information systems described in the directory has reached nearly 140. Approximately 70 data information

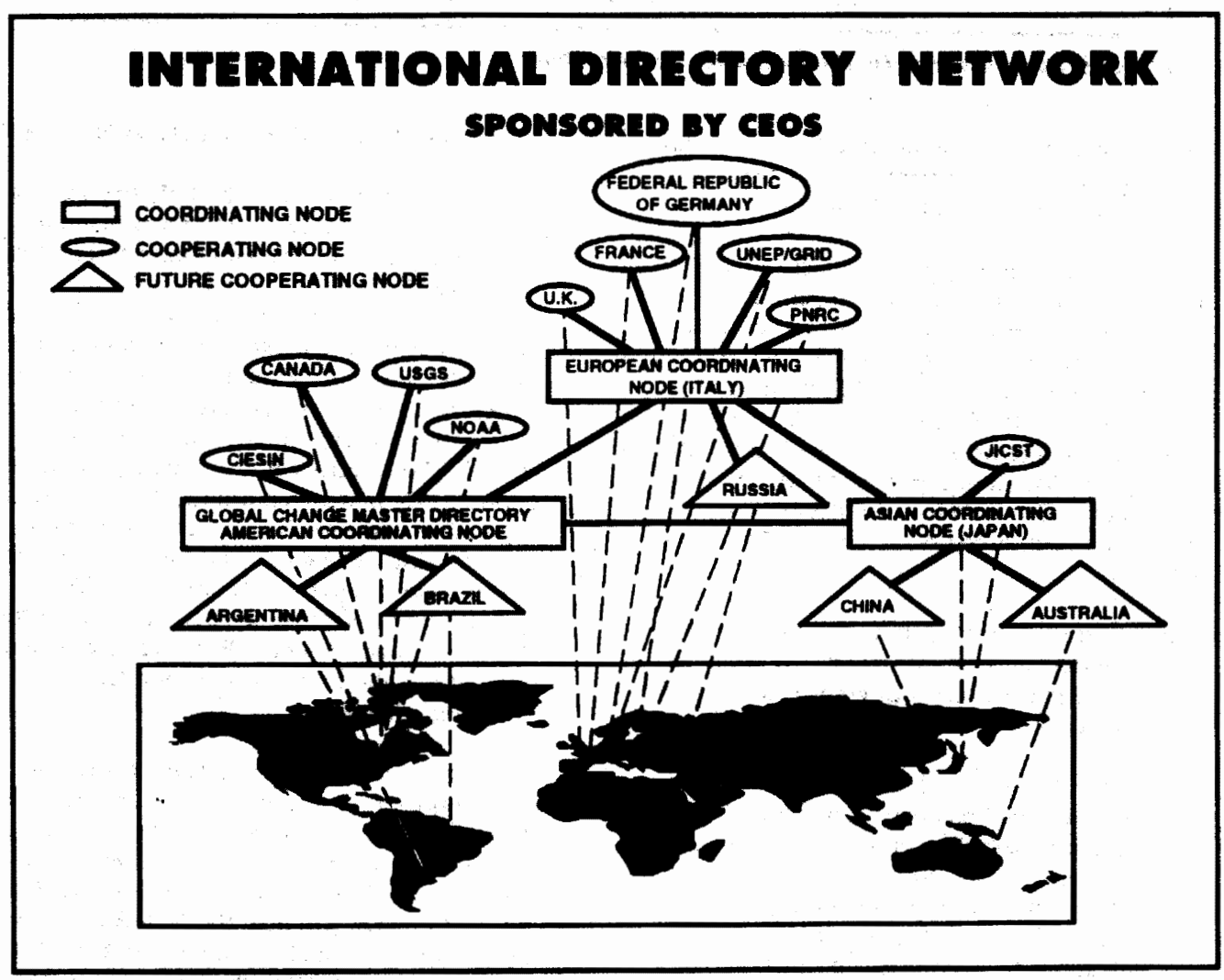

Figure 4. International Directory Network

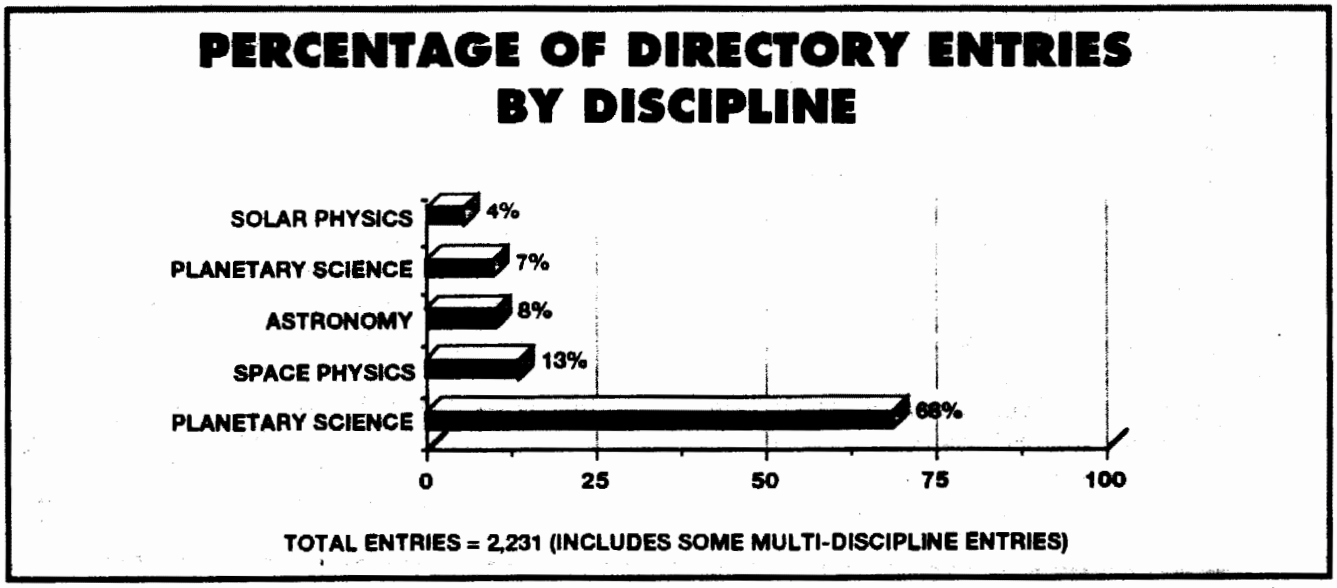

Figure 5. Percentage of Directory Entries by Discipline

systems may be directly accessed from the directory through an automated network link performed automatically upon request by the user.

For more than eight years a project called Catalog Interoperability or CI has been seeking to enable rapid and efficient identification, location, and access to data of interest to the science community. It started as a NASA effort but now includes representatives from other U.S. federal agencies, international agencies, and academic institutions. The goal of the CI group is to create a worldwide data information network composed of interconnected directory, guide, and inventory systems.

The first steps to establishing this network were to create directories to aid in finding data. The NASA Master Directory was created to serve this purpose for NASA.

A common format for describing data sets on the directory level has been developed by the Catalog Interoperability group, called the Directory Interchange Format (DIF), which is used as the basis of information to be shared among the directories. These DIF files can be passed among the directories to keep their information up to date.

THE INTERCONNECTED DIRECTORY SYSTEM

With the development of the DIF, the sharing of information among directories was made significantly easier. An interconnected International Directory Network (IDN) that would share information via DIF file exchange was formed. Figure 4 shows the present configuration of the directory system. (See page 33.) These are just the directory nodes. Connections to other data information systems (guides, inventories) are not shown. The directory nodes include the three coordinating nodes that are identical copies of each other and have the main responsibility for gathering, reviewing, and distributing data information throughout the network. The coordinating nodes are located at GSFC; at the European Space Agency (ESA) office in Frascati, Italy; and at the Earth Observation Center in Hatoyama, Japan.

Cooperating nodes share in the information distribution by contributing directory information. They may have full or partial directory data bases according to their needs. The present nodes are the Canadian Centre for Remote Sensing (CCRS) node in Ottawa, Canada; the NOAA Earth System Data Directory (NESDD); the USGS Earth Science Data Directory (ESDD); the Deutsches Forschungs

Anstaltfuer Luft und Raumfahrt (DLR) node in Munich, Germany; the United Nations Environmental Programme/Global Resources Information Data Base (UNEP/GRID) node in Geneva, Switzerland; the Antarctic data base directory node in Italy (PNRA); the British National Space Center node (U.K.); the French space agency node (CNES); the Japan Information Center for Science and Technology (JICST); and the Consortium for International Earth Science Information Network (CIESIN) distributed nodes. A number of additional nodes are planned for the near future.

MASTER DIRECTORY STATUS

The information content of the directory has made similar progress. As shown in Figure 5, over 2,000 entries are contained in the directory, describing the most useful and usable data sets in the five major discipline categories. (See page 34.) Since more than one data set can be described in a single entry (and sometimes tens to hundreds may be aggregated in this way), there are many more than 2,000 data sets described in the directory. Hundreds of these were added in the past year, and many of the existing entries were reviewed and/or revised. This reflects the emphasis on keeping information current as well as maintaining quality and utility of the entries rather than concentrating only on increasing quantity. The number of entries will increase more rapidly as the new directory nodes of the IDN begin to describe their data holdings and the data in their surrounding community.

DIRECTORY ACCESS

The best way to reach an understanding of the nature and utility of the directories is to try them. Table 23 shows the procedures for accessing the directory at NASA/GSFC through several networks or via dial-in line. (See below.)

CATALOG INTEROPERABILITY

As mentioned previously, the directories are only the first step in achieving the goals of catalog interoperability. Once users have determined from the directory where data of interest might reside, they usually need to obtain more information about the data and/or determine whether data exist for a particular criterion, such as time or location. The CI project seeks to make the simple interconnection process (level 1 interoperability) ever more efficient

SPAN	DIAL-IN LINES
$ SET HOST NSSDCA	**Dial 301-286-9000**
USERNAME: **NSSDC**	*CONNECT 1200 (or 2400 or 300)*
INTERNET	**Enter several carriage returns**
TELNET 128.183.36.23	*ENTER NUMBER*
USERNAME: **NSSDC**	**MD**
OMNET	*CALLING 55201 (or 55202)*
GOTO NSSDC	*CALL COMPLETE*
	Enter several carriage returns
	USERNAME: **NSSDC**

ITALICS INDICATE RESPONSE FROM THE COMPUTER.

Table 23. Directory Access

Several methods of potential use to increase interoperability are currently being applied in limited situations. Context passing (level 2 interoperability) was demonstrated in 1990 using the Master Directory and several remote systems. A limited form of automated multi-system searching (one form of level 3 interoperability), which does not assume Standard Query Language (SQL) data bases in remote systems, is being developed for version 0 of the EOS project Data and Information System (EOSDIS). The Astrophysics Data System (ADS) is testing multi-system searching through uniformizing data base overlay software. Other groups are also testing different methods of multi-system searching. The lessons learned from these various approaches will be applied more generally in the future to improve the overall search process and access to data. Figure 4 suggests a future scenario for various disciplines that combines the IDN with a variety of automatic connections into the discipline information systems using a mixture of levels of interoperability. (See page 33.) The goal is to provide the highest level of interoperability for the user wherever it proves valuable and cost-effective.

A.3 Astronomical Data Center (ADC)

The Astronomical Data Center (ADC) is part of the National Space Science Data Center/World Data Center-A for Rockets and Satellites (NSSDC/WDC-A-R&S) at NASA Goddard Space Flight Center. The ADC acquires, verifies, formats, documents, and distributes catalogs containing astronomical data in computer-readable form. It also develops and maintains software tools to access these data.

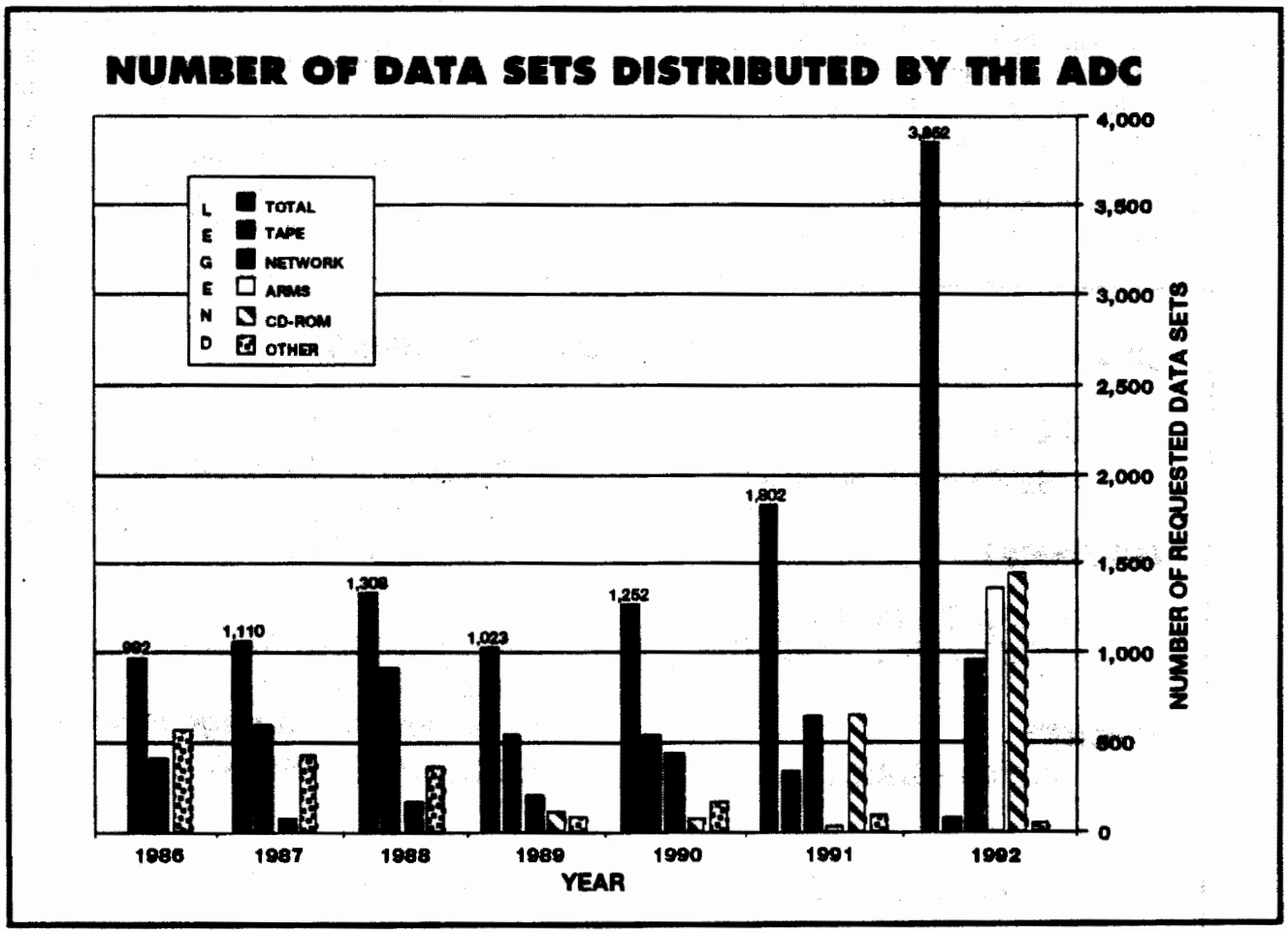

Figure 6. Requests and Number of Data Sets Distributed by the ADC

During 1992 the ADC ingested 45 new and updated catalogs, including several significant acquisitions, such as the *CfA Redshift Catalogue* (Huchra et al., 1992); *Hipparcos Input Catalogue* (Turon et al., 1992); *Catalogue of Positions and Proper Motions - South* (Bastian et al., 1992) and *A Catalogue of Quasars and Active Nuclei*, 5th Edition (Veron-Cetty and Veron, 1991). The ADC archives currently contain more than 670 catalogs of astrometry, photometry, spectroscopy, radio, and other miscellaneous data for stellar and non-stellar objects. These catalogs were acquired as direct contributions from the international astronomical community, exchanges with the Centre de Données Astronomiques de Strasbourg (CDS), and exchanges with other astronomical data centers worldwide.

To date the ADC has distributed more than 10,000 data sets via computer networks, tape, CD-ROM, microfiche, and microfilm to more than 3,000 individual requesters worldwide. The ADC has provided data and/or software to various space astronomy projects, such as the InfraRed Astronomical Satellite (IRAS), the International Ultraviolet Explorer (IUE), the Hubble Space Telescope (HST), the Cosmic Background Explorer (COBE), the ASTRO 1 Ultraviolet and X-Ray Astronomy Space Shuttle Mission, and the High Energy Astrophysics Science Archive Research Center (HEA-SARC).

During 1992 the ADC staff handled requests for 1,092 catalog data sets with an average response time of only 1.5 days for network distribution and six days for tape distribution. This is the result of hard work and dedication to providing the best service possible. Figure 6 shows the number of requested ADC data sets per year broken down by distribution method. (See page 36.)

THE ADC CD-ROM, SELECTED ASTRONOMICAL CATALOGS, VOLUME I

The ADC Compact Disc-Read Only Memory (CD-ROM) set has been one of the most frequently requested data sets in 1992. It has been used by the community as a convenient compilation to make catalogs available from on-line data bases for further research. Especially searches across catalogs were made easier because the ADC CD-ROM used consistent headers from catalog to catalog.

The NSSDC/ADC demonstrated a range of interactive data services and distributed hundreds of CD-ROMs at the 179th meeting of the American Astronomical Society (AAS), held in Atlanta, Georgia, on January 12-16, 1992. Those who are not among the over 1,600 astronomers worldwide who have already requested and received Volume I should know that the "Astronomical Data Center CD-ROM, Selected Astronomical Catalogs, Volume I" is currently available from the NSSDC/WDC-A-R&S.

The ADC CD-ROM is a two-disk set containing 114 astronomical catalogs, including several significant new releases, such as the *Astrographic Catalog Reference Stars* (Corbin and Urban, 1991); *IRAS Faint Source Catalog, Version 2.0* (IPAC, 1990); and preliminary versions of the *General Catalog of Trigonometric Stellar Parallaxes* (van Altena et al., 1991), the *Catalog of Nearby Stars* (Gliese et al., 1991), and the *Fifth Edition of the Bright Star Catalog* (Hoffleit and Warren, 1991), prepared especially for this CD-ROM release.

The catalogs appearing on the ADC CD-ROM were chosen in consultation with the astronomical data centers in China, France, the Federal Republic of Germany (FRG), Japan, and the Commonwealth of Independent States (C.I.S.). The International Astronomical Union has lent valuable support in the form of a grant to defray costs of distributing the data to small institutions in developing countries that might otherwise have difficulty in acquiring and using such large volumes of data.

Requests for this CD-ROM set may be placed using the On-Line Information System described in Table 24 (select catalog number 6906A) or may be forwarded to the NSSDC Coordinated Request and User Support Office (CRUSO). (See page 38.)

THE ADC ON-LINE INFORMATION SYSTEM

In 1992 the ADC On-Line Information System was developed further with improved capabilities. It provides information on all catalogs held at the ADC and allows interactive submission of requests. The ADC On-Line Information System was the most

frequently used method in the efficient location of astronomical catalogs of interest and in the fulfillment of requests for the data sets selected. The system is maintained under a "captive" account on the NSSDC VAX cluster called the NSSDC On-Line Data and Information Service (NODIS). Users may connect to the NODIS account over NSI/DECnet or Internet. To connect through NSI/DECnet, users can execute

SET HOST NSSDCA

To connect through Internet, execute

telnet nssdca.gsfc.nasa.gov or
telnet 128.183.36.23

Once connected, users enter "NODIS" in response to the "Username:" prompt; no password is

GENERAL INQUIRIES DEALING WITH CATALOG REQUESTS Contact:

Requesters WITHIN the United States:

NSSDC Coordinated Request and User Support Office
NASA Goddard Space Flight Center
Code 633.4
Greenbelt, Maryland 20771, U.S.A.

Requesters OUTSIDE the United States:

World Data Center-A for Rockets and Satellites
NASA Goddard Space Flight Center
Code 633
Greenbelt, Maryland 20771, U.S.A.

For all requesters:

Internet: REQUEST@NSSDCA.GSFC.NASA.GOV
NSI/DECnet: NSSDCA::REQUEST
Telephone: (301) 286-6695; FAX: (301) 286-4952

GENERAL INQUIRIES ON ASTRONOMICAL CATALOGS, DATA SUBMISSION, AVAILABILITY, AND THE ADC ON-LINE INFORMATION SYSTEM:

Gail L. Schneider
National Space Science Data Center
Hughes STX
Code 633
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771, U.S.A.
Internet: GAIL@NDADSA.GSFC.NASA.GOV
NSI/DECnet: NDADSA::GAIL
Telephone: (301) 286-8310; FAX: (301) 286-4952

QUESTIONS ABOUT SCIENTIFIC CONTENT OF CATALOGS:

N. Paul M. Kuin
National Space Science Data Center
Hughes STX
Code 633
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771, U.S.A.
Internet: KUIN@NSSDCA.GSFC.NASA.GOV
NSI/DECnet: NSSDCA::KUIN
Telephone: (301) 286-0677; FAX: (301) 286-4952

Nancy G. Roman
National Space Science Data Center
Hughes STX
Code 633
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771, U.S.A.
Internet: ROMAN@HYPATIA.GSFC.NASA.GOV
NSI/DECnet: NSSDCA::ROMAN
Telephone: (301) 286-4770; FAX: (301) 286-4952

QUESTIONS ON CD-ROM DEVELOPMENT:

Lee E. Brotzman
National Space Science Data Center
Hughes STX
Code 633
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771, U.S.A.
Internet: BROTZMAN@NDADSA.GSFC.NASA.GOV
NSI/DECnet: NDADSA::BROTZMAN
Telephone: (301) 513-1629; FAX: (301) 513-1608

GENERAL QUESTIONS AND COMMENTS ON ADC SERVICES AND SUPPORT:

N. Paul M. Kuin
National Space Science Data Center
Hughes STX
Code 633
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771, U.S.A.
Internet: KUIN@NSSDCA.GSFC.NASA.GOV
NSI/DECnet: NSSDCA::KUIN
Telephone: (301) 286-0677; FAX: (301) 286-4952

Joseph H. King
National Space Science Data Center/
World Data Center-A for Rockets and Satellites
Code 633
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771, U.S.A.
Internet: KING@NSSDCA.GSFC.NASA.GOV
NSI/DECnet: NSSDCA::KING
Telephone: (301) 286-7355; FAX: (301) 286-4952

Table 24. ADC Contact and Subscription Information

required. NODIS is integrated with the NSSDC Request Activity and Name Directory (RAND). The system will ask for the user's name and check the NSSDC requester data base for a match. If users have never requested data from NSSDC before, they should enter complete information so that any catalog requests registered later will be filled promptly and correctly.

Currently, NODIS has two menus. On the old NODIS main menu, the Astronomical Data Center is option 10. On the new NODIS menu, it is option 2.1. Once connected to the ADC option, there will be some system messages followed by the opening menu of search options. The on-line system assumes that the user is using a VT100-compatible terminal and emits ANSI escape sequences to clear the screen.

The system has three search options: by ADC (CDS) number, by text search of abbreviated titles, and by text search of keywords. Each of these options is designed to create a list of catalogs meeting the given criteria. Catalogs are then selected from the list, and information such as the full title and reference, file format description, comments, and the current distribution status is displayed. Requests can be entered interactively; the system guides users through, giving the information necessary to fulfill the request.

THE NDADS AUTOMATED RETRIEVAL MAIL SERVICE (NDADS ARMS)

In December 1991 the ADC-held data were written to optical disk platters with the disks residing in a robotic "jukebox" near-line environment. The NDADS Automated Retrieval Mail System (ARMS) permits researchers to rapidly retrieve selections from the current ADC NDADS holdings. Requests are submitted via electronic mail, and the data may be retrieved via anonymous FTP or default NSI/DECnet copy. It is also possible to arrange to have the data sent directly to the requester's computer.

This service has changed in 1992 the common way of distribution of machine readable catalogs. Automatic request handling via NDADS ARMS for retrieval and using the electronic networks for distribution became very important.

For more information on ARMS, users can send an electronic mail message as follows:

via NSI/DECnet, send to

NDADSA::ARCHIVES
Subject: SEND INFORMATION

or via Internet, send to

ARCHIVES@NDADSA.GSFC.NASA.GOV
Subject: SEND INFORMATION

No information is required in the body of the mail message in order to receive a reply. Please note that this is an automated service. Although the mail is monitored, staff do not normally reply to E-mail sent to ARCHIVES.

ADC ELECTRONIC NEWSLETTER

The ADC started to publish the quarterly *ADC Electronic Newsletter* in 1992 to inform the astronomical community about new data holdings and services. Issues contain lists of the latest acquisitions, articles about ADC services, and errata for the ADC CD-ROM and other catalogs. More than 800 astronomers worldwide received the *ADC Electronic Newsletter* in 1992.

To acquire a new subscription to the *ADC Electronic Newsletter*, send E-mail to

LISTSERV@HYPATIA.GSFC.NASA.GOV

In the body of the mail message (not the subject line), put only the following command:

SUBSCRIBE ADCNEWS Your Name

where "Your Name" is a full name, not a user ID or E-mail address. The LISTSERV program will get the proper E-mail address for the subscription from the mail header. Once the subscription is accepted, a "welcome" message will explain how to get back

Send subscription questions via E-mail to

ADC-INFO@HYPATIA.GSFC.NASA.GOV

A.4 Visual Reproduction Facility (VRF)

The NSSDC's Visual Reproduction Facility (VRF) continued to upgrade its capabilities in 1992 to provide quality support of photographic and audio-visual needs to the scientific research community. The current hardware inventory has been enhanced with the addition of new equipment. The purchase of a Fujimoto Image Color Processor CP-51 has resulted in the start of all in-house color enlargement work and allows the duplication and shipment of material within hours. This color processor has increased the NSSDC's ability to provide a service to requesters. A VHS that will convert NTSC tapes to PAL and back to NTSC will allow NSSDC to provide tapes of its data to the world.

In maintaining conformance with its mission, the facility has continued to provide a variety of visual formats to the science community. The Apollo, Viking Orbiter and Lender, Voyager I and II, and Magellan data continue to be the most requested missions. The past year has seen a new look at Mars by the science community. The VRF has been conscientiously striving to sustain its efforts to improve the accessibility of visual data from NASA missions. (See Figure 7 below and Figure 8 on page 41.)

Cost cutting measures at the data center this year almost necessitated closure of the VRF. The facility however, will continue in its services to NSSDC's requester community.

The laboratory has handled some very substantial jobs this year. Some of these were completed for Ms. Rosemary E. Steinat of the Regional Planetary Image Facility, Center for Earth and Planetary Studies, National Air and Space Museum; Dr. Jouko T. Raitala of University of OULU, the Department of Astronomy, Finland; Dr. Philippe L. Masson, director of Laboratorie de Geologie Dynamique Interne Center D'orsay, Université de Paris XI, Orsay Cedex, France; Dr. Ronald Greeley of the Department of Geology, Arizona State University, Tempe, Arizona; and Mr. Kent D. Trego of the Planetology Research Institute, Palo Alto, California.

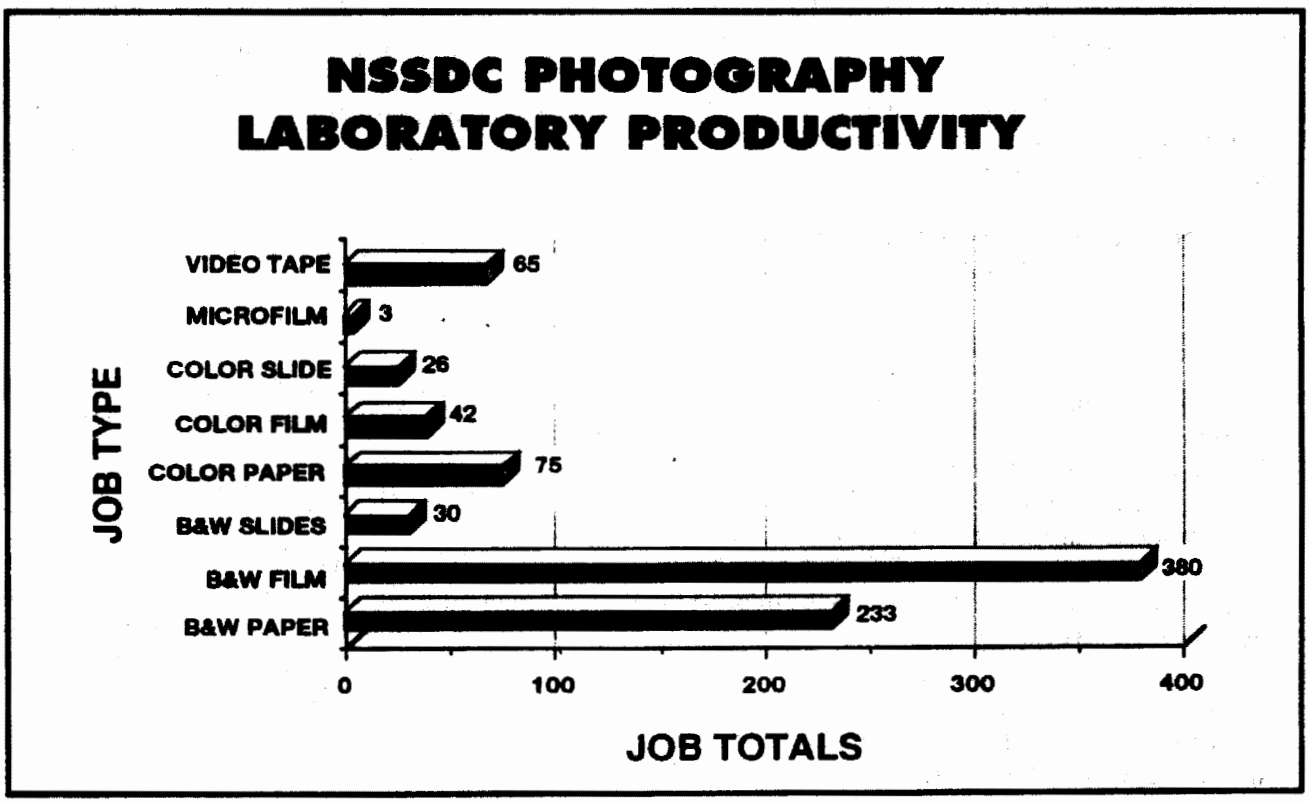

Figure 7. Photo Laboratory Productivity

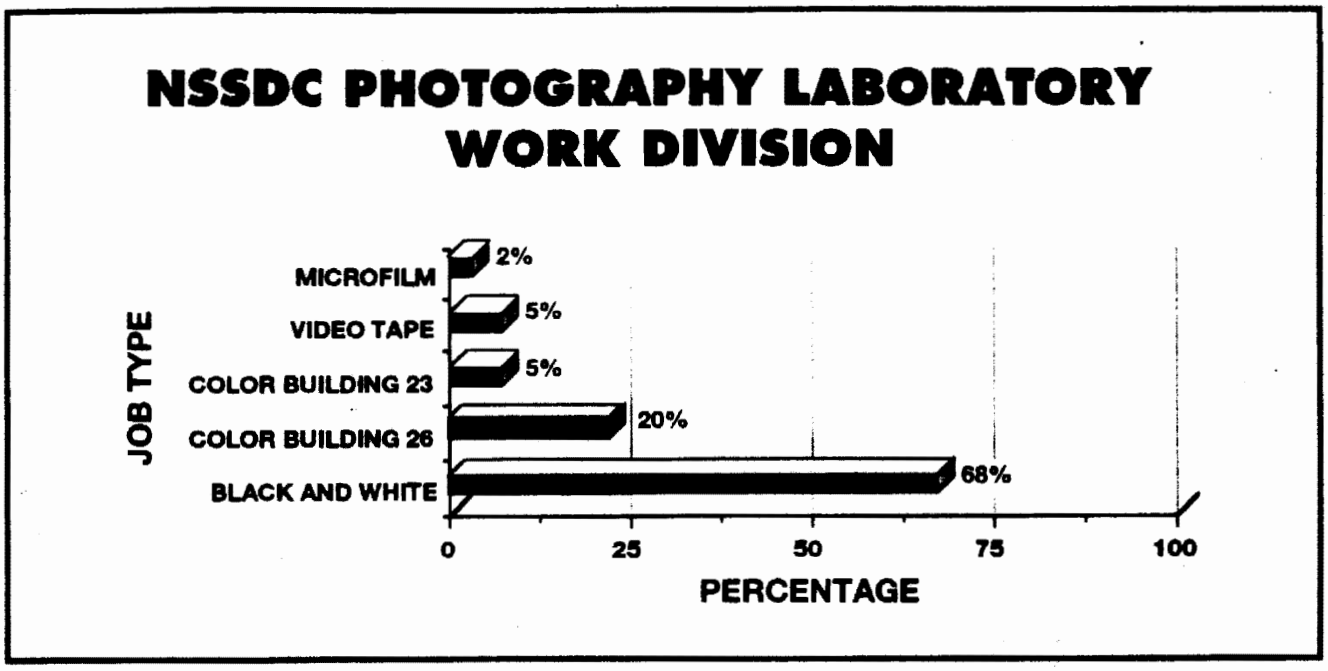

Figure 8. NSSDC Photo Laboratory Work Division

The past year has also reflected continued support for the VRF's school intern programs. One student from the Achievement Course Training (ACT) program and two from the Summer High School Apprentice Research Training (SHARP) program have been working in the laboratory performing routine tasks assigned by their supervisor. These internships have helped students to gain an insight into the internal operations of NASA and the laboratory while the facility simultaneously has benefitted from the enthusiastic help of students who someday might be data requesters themselves.

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NSSDC ACRONYMS AND ABBREVIATIONS LIST

AAS	American Astronomical Society
ACT	Achievement Course Training
ADC	Astronomical Data Center
ADS	Astrophysics Data System
AIAA	American Institute for Aeronautics and Astronautics
AIM	Automated Internal Management File
ANSI	American National Standards Institute
ARMS	Automated Retrieval Mail System
ARPAnet	Advanced Research Projects Agency Network
CCRS	Canadian Centre for Remote Sensing
CCSDS	Consultative Committee for Space Data Systems
CDF	Common Data Format
CDHF	Central Data Handling Facilities
CD-ROM	Compact Disc-Read Only Memory
CDS	Centre de Données de Strasbourg
CI	Catalog Interoperability
CIESIN	Consortium for International Earth Science Information Network
C.I.S.	Commonwealth of Independent States
CNES	French space agency node
COBE	Cosmic Background Explorer
COHO	Coordinated Heliospheric Observation
CRUSO	Coordinated Request and User Support Office
CZCS	Coastal Zone Color Scanner
DBMS	Data Base Management System
DE	Dynamics Explorer
DECnet	DEC Networking Products (generic family name)
DIF	Directory Interchange Format
DLR	Deutsches Forschungs Anstaltfuer Luft und Raumfahrt
EOS	Earth Observing System
EOSDIS	EOS project Data and Information System
ERB	Nimbus 7 Earth Radiation Budget Instrument
ERBE	Nimbus 7 Earth Radiation Budget Experiment
ERBS	Earth Radiation Budget Satellite
ESA	European Space Agency
E-SPAN	SPAN in Europe
FRG	Federal Republic of Germany
FTP	Anonymous File Transfer Protocol
GCMD	Global Change Master Directory
GSFC	Goddard Space Flight Center
HEAO	High Energy Astrophysics Observatory
HEASARC	High Energy Astrophysics Science Archive Research Center
HST	Hubble Space Telescope
IDA	Interactive Data Archive
IDL	Interactive Data Language

IDN	International Directory Network
IMP	Interplanetary Monitoring Platform
IRAND	Interactive Request Activity and Name Directory
IRAS	Infrared Astronomical Satellite (The Netherlands-NASA-U.K.)
ISCCP	International Satellite Cloud Climatology Project
ISEE	International Sun-Earth Explorer
ISO	Information Systems Office
ISO	International Standards Organization
ISTP	International Solar-Terrestrial Physics
IUE	International Ultraviolet Explorer (satellite, NASA-U.K.-ESA)
IUWDS	International URSIGRAM and World Days Service
JICST	Japan Information Center for Science and Technology
JPL	Jet Propulsion Laboratory (NASA)
MD	Master Directory (NASA)
NASA	National Aeronautics and Space Administration
NCDS	NASA's Climate Data System (formerly PCDS)
NDADS	NSSDC Data Archive and Distribution System
NESDD	NOAA Earth System Data Directory
NMD	NASA Master Directory
NOAA	National Oceanographic and Atmospheric Administration
NODIS	NSSDC On-Line Data and Information Services
NOST	NASA/Science Office of Standards and Technology
NRAO	National Radio Astronomy Observatory
NSDF	NSSDC Supplemental Data File
NSSDC	National Space Science Data Center (NASA)
OMNI	Interplanetary Medium Data
OSSA	Office of Space Science and Applications
PIMS	Personnel Information Management System
PNRA	Antarctic data base directory node in Italy
RAND	Request Activity and Name Directory
REQ	NSSDC Data Request Service
ROSAT	Roentgen Satellite (German X-ray research satellite)
RSI	Research Systems Incorporated
RSIRS	Relational System for Information Retrieval and Storage
SAGE	Stratospheric Aerosol and Gas Experiment
SHARP	Summer High School Apprentice Research Training Program
SIR	Shuttle Imaging Radar
SPACEWARN	World Warning Agency for Satellites
SPAN	Space Physics Analysis Network
SPOT	Systeme Probatoire d'Observation de la Terre
SQL	Standard Query Language
SSDOO	Space Science Data Operations Office
SSI	Solid State Imaging
STELAR	Study of Electronic Literature for Astronomical Research

STEP	Solar-Terrestrial Energy Program
STIS	Standards and Technology Information System
TOMS	Total Ozone Mapping Spectrometer
TRF	Technical Reference File
U.K.	United Kingdom
UNEP/GRID	United Nations Environmental Programme/Global Resources Information Data Base
USGS	United States Geological Survey
USRSDC	U.S. ROSAT Science Data Center
US-SPAN	SPAN in the U.S.
VRF	Visual Reproduction Facility
WDC-A-R&S	World Data Center A for Rockets and Satellites
WORM	Write-Once, Read-Many