DATA MANAGEMENT PLAN

for the

ARCHIVE OF OLS AND SPACE ENVIRONMENT DATA RECEIVED FROM AFGWC ON MAGNETIC TAPE

at the

National Geophysical Data Center

~~For approval~~ Approved by the NESDIS Data Management Advisory Council on June 23, 1992

June 11, 1992

Background

The Defense Meteorological Satellite Program (DMSP) mission is to provide an enduring capability to collect and disseminate global visible and infrared (IR) cloud cover and other specialized meteorological, oceanographic, and solar-geophysical data to support DoD operations. DMSP satellites are in low-altitude, sun-synchronous, polar orbits with equatorial crossing local times near dawn-dusk and noon-midnight. The DMSP program has meteorological objectives similar to those of the NOAA polar orbiting satellite program, e.g., cloud imaging and atmospheric temperature profiling, but also has some distinct scientific and technological differences, e.g., geophysical parameters derived from microwave imagery, in-situ plasma composition, density, temperature and velocity measurements, and energetic auroral particle fluxes. Satellite operations are also similar with "direct readout" data being transmitted at all times and data also being stored on tape recorders; however, DMSP telemetry is encrypted over all areas except the Antarctic. A brief comparison of the DMSP and NOAA cloud imagery systems and derived Environmental Data Records (EDRs) is shown in Appendix A.

Since 1972, when DMSP data were declassified, National Geophysical Data Center (NGDC) and National Climatic Data Center (NGDC) staff cooperated with the USAF Air Weather Service to maintain this national resource of meteorological, space environmental and oceanographic data. The first Memorandum of Agreement for the archival of DMSP data was signed in 1976 by Thomas S. Austin, Director of EDS, and Clarence E. Zienert, AWS, Chief of Staff.

Microfilm copies of night-time imagery showing the first large-scale displays of the aurora borealis and aurora australis have been archived at NGDC since 1972. Similar archives of meteorological imagery made at Global Weather Central (AFGWC) were maintained at the University of Wisconsin and then at the National Snow and Ice Data Center (NSIDC). (Digital archives were considered to be too costly in 1972.) These analog archives were combined with digital data, processing software, product generation, and empirical models from selected mission sensor measurements of auroral ions and electrons in 1975 at NGDC and with digital data and products from the SSM/I microwave imager over the polar regions at NSIDC since 1987.

Since 1987 subsets of the decoded DMSP data stream have been placed on the Shared Processing Network (SPN) including SSM/T, SSM/I, SSM/T-2, very low resolution OLS imagery, and EDRs. These data are received at NESDIS/OSDPD and shipped to SDSD on 3480 cartridges for archive, distribution and retrospective use. The basic data services provided by SDSD are tape copies.

In 1990 when the analog Operational Linescan System (OLS) processing at AFGWC was being drastically reduced, two Academy of Sciences committees, the Office of the Federal Coordinator, and meteorological and space physics researchers asked NGDC and NSIDC to investigate the feasibility of a digital archive of OLS data. A technical group representing NGDC, NSIDC, NCDC, AFGWC, Harris Corp., Aerospace Corp., and the DMSP Program Office was formed in 1991 and it proposed that the archive incorporate the complete DMSP data stream as it is received at AFGWC. In 1991, NASA and the DMSP Program Office provided funding to develop and install hardware and software at AFGWC to write the data onto high density 8 mm tapes. In January, the hardware was tested and the software was reworked. The system was finally fully operational in May 1992 and NGDC is receiving two 5 GB tapes in a compressed format every day.

Data Processing at NGDC

Following the recommendations set forth by the DMSP Mission Sensor Working Group (MSWG), as listed in Appendix B, that incorporate NGDC and NESDIS data management policies and procedures, NGDC scientists developed a list of tasks and programs for processing the raw satellite data tapes received from AFGWC. The DMSP MSWG consists of Principal Investigators and engineers responsible for the design, construction, and integration of each sensor, scientists responsible for the calibration and integrity of all data from each sensor, operational users of the data, and researchers doing retrospective analysis of data for selected events and validation of algorithms to derive geophysical parameters. The DMSP MSWG requested that NGDC complete most of the processing tasks so each user would not have to spend significant resources to derive usable data.

Daily tapes of OLS and mission sensor data are now being received. They contain about 3.5 GB of de-crypted, demuxed, partially decommutated and reformatted data in a binary format. The data are organized by scan line; however, logical subsets must be extracted, calibrated, and quality controlled. Mission sensor data are provided in the format that the onboard processor transmits them, so these data must also be decommutated. The lists of processing and archival tasks are as follows:

1. Decompress the incoming Exabyte tape,

2. Reorder the data stream so that time is increasing from the beginning of the satellite telemetry to the end,

3. Decommutate, restructure and separate the Mission Sensor data into logical subsets and merge with satellite ephemeris files,

4. Construct logical data sets by instrument, region, and satellite and apply calibration values to convert input data to scientific units,

5. Maintain data inventories by data set, satellite, instrument, date-time group, data coverage, data quality and sub-orbital unit consistent with NOAA and NASA guidelines,

6. Assess data quality through automated techniques as recommended by the principal scientists who are responsible for each sensor,

7. Develop summary data files that characterize each data set by sub-orbital unit to improve usability and to make quality assessments,

8. Construct and quality control ephemeris files by reverse navigation techniques to the recommended temporal and spatial accuracy for geolocation of in-situ data and navigation of imagery,

9. Modify existing software to navigate OLS imagery,

10. Generate a browse image system comparable to EROS, NCAR and Scripps systems for in-house use and evaluate the system for on-line services,

11. Maintain archives and a tape inventory in accordance with NGDC policy including a local off-site archive for easy access and maintainability, and

12. Provide copies to requestors in accordance with NOAA and NESDIS pricing policy.

Once operational, NGDC will complete these tasks within two weeks of the receipt of the data. NGDC requested and received operational software from AFGWC, FNOC, and Aerospace Corp. which must be modified and/or rewritten. Funding for the effort to date has been received from the DMSP Program Office, ESDIM, Climate and Global Change, NASA Earth Science and Applications Division, NASA Space Science, and a redirection of NGDC programs. Our basic services will be limited to providing archive tape copies on Exabyte or 6250 bpi tapes, time and/or region selected data on tape, hard copy imagery upon request, and a data inventory system. We will not develop new algorithms or products to derive geophysical parameters (EDRs) as part of the basic program.

Local researchers in NGDC, NSIDC, ERL, University of Colorado, and NCAR will provide scientific hardware and software expertise and guidance. This may eventually include product development as time, interest, and resources are received. The basic program is expected to be operational in the second quarter of FY93. We plan to eliminate the backlog of data from 1992 around May 1993. At this time our highest priority product is an "on-line" browse of OLS imagery.

NGDC is planning a computing facility which will process the incoming and backlog data, will send archive tapes to STPD, NSIDC and a local off-site facility, will generate browse images, and will complete all standing and routine data requests. The system is being sized to complete normal processing within 6 hours, to eliminate the backlog of tapes at a rate of 5 GB of incoming data per day, and the two systems will be fully complementary. Though we are presently testing Sun, SGI, DEC, HP and IBM equipment, it now appears that we will purchase three Sun 690 MPs with four processors and 20 GB of hard disk each. One machine will process the current data, one will process the backlog and the third will act as a file server and for quality control. Processing software is being developed by NGDC, NSIDC, and Johns Hopkins following our schedule, testing, and acceptance guidelines and software manual.

All data requests, checks, and pricing will follow NGDC policy. Routine orders will be completed by the DMSP facility. Special orders for OLS, SSJ/4, SSI/ES, SSM, SSULI and SSUSI data and products will be handled by NGDC/STPD. Special orders for OLS data and products developed for the snow and ice community will be sent to NSIDC. NGDC will support NSIDC's data request effort commensurate with their requests. All groups are encouraged to develop and manage new products with copies to be sent to the local off-site facility.

This data management plan does not address the disposition of the SSM/I, SSM/T and SSM/T2 data on the incoming tapes. This will be included in a NESDIS-wide data management plan for these data types, to be prepared at a later time.

Advisory Committee

Because retrospective use of DMSP data crosses several scientific disciplines and important agencies, we propose that an advisory panel be formed to provide policy and procedures for the DMSP data archive. To date, we have used the DMSP Mission Sensor Working Group to provide the initial direction. We will now focus on retrospective use of DMSP data by environmental researchers. We plan to seek representation from the meteorology, space physics, cryospheric science and oceanography communities as well as NESDIS, DMSP, USAF, and the Navy. We would plan an annual meeting with status reports, program plans and current issues.

Shared Processing Network (SPN)

Operational programs in support of the Shared Processing Agreement (SPA) will not be directly affected by this DMSP data archive program as directed in the associated Memorandum of Agreement. The SPA addresses real-time data transmission, processing, and support and this program deals with the archive of DMSP data for retrospective use only. However, from the archivist point of view, data transmitted via tape should not suffer from transmission dropouts, operational restrictions at AFGWC, or processing time limitations. As a result, we will routinely provide copies of our SSM/I, SSM/T and SSM/T-2 data sets to SDSD or OSDPD, if desired. In return, we would request copies of their EDRs.

A number of algorithms has been developed to infer the same geophysical parameter (or EDR) from remotely sensed DMSP data. Algorithm development properly lies within the meteorological, space physics, oceanographic or cryospheric research communities and our role should be to encourage such research activity. However, if one maintains an archive of EDRs, he/she should also maintain an archive of the input data, so that the EDRs may be rederived from a new algorithm and the historical path remains consistent.

Data from the microwave imager (SSM/I), the temperature radiometer (SSM/T), and the water vapor profiler (SSM/T-2) are transmitted over SPN in near-real time to support operational requirements. Similar data from the same instruments are transmitted via tape to NGDC, and similar data sets will fall out of the data processing scheme presented here. A detailed comparison should be undertaken by the SSM/I task team to document the differences resulting from the data transfer techniques, satellite ephemeris, and data processing at NGDC, OSDPD, and SDSD.

OLS data from the Satellite Global Data Base at AFGWC are also transmitted over SPN. These data are lower in spatial and intensity resolution than the OLS low resolution data sent on high density tape. Since these data are a subset of the tape data, they are not recommended for archival services by NESDIS pending approval of this system by DMAC and this recommendation by the Executive Committee of SPN.

The Operational Linescan System - OLS

The primary sensor on all DMSP satellites is the OLS which records visual and IR emissions from the Earth's surface and atmosphere. The OLS consists of scanning optical telescopes driven in a sinusoidal motion to

maintain a constant, instantaneous field-of-view along the approximate 3000 km scan. The visual channel is limited to the spectral range of 0.4 to 1.1 microns and IR channel covers the range from 10 - 13 microns. The scanning assembly maintains an approximately 0.5 km footprint which is reduced to 2.7 km by onboard processing. High resolution data or "fine" data are selectively recorded. All lower resolution data are recorded to provide global coverage.

IR system counts are automatically calibrated to very between 190° and 310° K of effective blackbody or brightness temperatures. The visual system gain is automatically adjusted across the scan to maintain fidelity across the day-night terminator. These gains are not recorded, so visual system counts cannot be converted to radiances, except under specified conditions.

NGDC processing will separate the OLS visual data from the IR data. The archive sets will be 1) global visual in counts, 2) auroral visual in counts, 3) global IR in °K, 4) fine visual in counts, and 5) fine IR in °K. An inventory will be maintained for each orbit for each data set. Products will be tape copies of selected data and hard copy images upon request. A local browse capability will be generated to facilitate data requests and local usability. Anticipated data rates are 1.6 GB per satellite-day. Presently the OLS on F-10 and F-11 are operational and data are being written to tape.

Auroral Electron and Ion Spectrometer - SSJ/4

SSJ/4 data have been instrumental in defining the transfer of energy, mass, and momentum through the magnetosphere-ionosphere system flowing along by the Earth's magnetic field. The SSJ/4 instrument consists of four electrostatic analyzers that record the number flux of precipitating ions or electrons at 20 fixed energy channels between 50 eV and 30 KeV. The primary source of the particles precipitating into the upper atmosphere is the northern and southern auroral zone. The incoming data rate is ~ 1 MB/satellite-day and SSJ/4 instruments are operational on F-8, F-10, and F-11.

NGDC has received and archived these data since 1975. We have written programs to compute the total energy flux and the average energy of incoming particles and boundaries of the auroral zone, polar cusp and polar cap. We have also constructed an empirical model called the Precipitating Electron Model for use with electrodynamic models of the upper atmosphere. The archive data base will consist of the number flux of precipitating electrons and ions over the polar regions with geocentric and magnetic coordinates of the satellite identified every 4 seconds.

The Ionospheric Plasma Monitor - SSI/ES

SSI/ES data have been instrumental in defining the flow of electrons and ions over the polar region including the auroral zone and polar cap. The SSI/ES instrument consists of 4 separate components; the drift meter, the scintillation meter, the Langmuir probe, and the retarding potential analyzer. Together, they measure the ambient number density and temperature of electrons and H^+ and O^+ ions, the vertical gradient in electron density and the drift speed of ionospheric plasma perpendicular to the satellite sub-tract. The data rate is 12 MB/satellite-day and presently SSI/ES instruments are operational on F-8, F-10, and F-11.

operational on F-8, F-10, and F-11.

NGDC processing will generate separate data sets for each component. Preliminary processed data will be copied and sent to AFGL for instrumental health issues; however, the archival data set will be processed past the linear calibration stage to the derived scientific units stage of number densities and temperatures. This was recommended by the Mission Sensor Working Group. Drift meter data from mid- and low-latitudes will be discarded. Satellite ephemeris will be added to the sensor data in the archive format.

New Mission Sensors

The next launch is scheduled to carry a 3-axis fluxgate magnetometer, SSM, mounted on a boom to free the measurements from contamination caused by electrical currents flowing within the spacecraft electronics. Two new ultraviolet imagers, SSULI and SSUSI are scheduled for launch beginning around 1995. They should provide remotely sensed data of ionospheric electron density profiles.

Data processing plans for all new instruments will follow the recommendations of the DMSP Mission Sensor Working Group as approved by the advisory committee.

REFERENCES

DMSP Data Archive, Data Format Handbook, Harris Government Information Systems Division, Omaha Operations, 301 Washington St., Belleview, NE 68005, 1992.

DMSP Data Specification, IS-YD-821, January 1977, Defense Meteorological Satellite Program, Los Angeles, CA, 1977.

Greenspan, M.E., P.B. Anderson and J.M. Pelagatti, Characteristics of the thermal plasma monitor (SSIES) for the Defense Meteorological Satellite Program (DMSP), S8-S10, AFGL-TR-86-0227, Air Force Geophysics Laboratory, Hanscom AFB, MA 01731, 1986.

Hardy, D.A., M.S. Gussenhoven and A. Huber, The Precipitating Electron Detectors (SSJ/3) for the Block 5D/Flights 2-5 DMSP Satellites: Calibration and Data Presentation, AFGL - TR-79-0210, Air Force Geophysics Laboratory, Hanscom AFB, MA 01731, 1979.

Hollinger, J. (ed.), DMSP Special Sensor Microwave/Imager Calibration/ Validation, Final Report, Volumes I and II, Naval Research Laboratory, Washington, DC, 1989.

Hollinger, J., R. Lo, G. Poe, R. Savage and J. Pierce, Special Sensor Microwave/Imager User's Guide, Naval Research Laboratory, Washington, DC, 1987.

The Defense Meteorological Satellite Program Sensors: An Historical Overview, DMSP Program Office, Los Angeles, CA, 1992.

Acronyms

AFGWC	Air Force Global Weather Central
AVHRR	Advanced Very High Resolution Radiometer
AWS	Air Weather Service
DEC	Digital Equipment Corporation
DMSP	Defense Meteorological Satellite Program
EDR	Environmental Data Record
EDS	Environmental Data Service
ERL	Environmental Research Laboratories
EROS	Earth Resources Observing Satellite
ESDIM	Earth System Data and Information Management
eV	electron volts
FNOC	Fleet Numerical Oceanography Center
GB	GigaByte = 10^9 Bytes
GHz	GigaHertz = 10^9 cycles per second
HP	Hewlett Packard
IBM	International Business Machine
IR	infrared
Kev	kiloelectron volt = 10^3 eV
km	kilometer
MB	megabyte = 10^6 bytes
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NDCD	National Climatic Data Center
NESDIS	National Environmental Satellite, Data and Information Service
NGDC	National Geophysical Data Center
NOAA	National Oceanic and Atmospheric Administration
NSIDC	National Snow and Ice Data Center
OLS	Operational Linescan System
ORA	Office for Research and Applications
OSDPD	Office of Satellite Data Processing and Distribution
SDSD	Satellite Data Services Division
SGI	Silicon Graphics, Inc.
SPN	Shared Processing Network
SSI/ES	Thermal plasma monitors
SSJ/4	Auroral electron and ion detectors
SSM	Three-axis fluxgate magnetometer
SSM/I	Microwave imager
SSM/T	Temperature radiometer
SSM/T-2	Water Vapor radiometer
SSULI	Ultraviolet limb scanning radiometer
SSUSI	Ultraviolet imager

STPD	Solar-Terrestrial Physics Division
USAF	United States Air Force
^{o}K	degrees Kelvin

Appendix A

NOAA/AVHRR vs. DMSP/OLS comparison

NOAA/AVHRR	system characteristics/(applications)	DMSP/OLS
1.1 km LAC 4.0 km GAC (degraded at edges)	**spatial resolution**	0.55 km 'fine' 2.7 km 'smooth' (constant across swa
good good	(sea ice leads) (meteorology)	better better
5 narrow channels ch1: 0.58-0.68 um ch2: 0.725-1.0 um ch3: 3.55-3.93 um ch4: 10.30-11.30 um ch5: 11.50-12.50 um	**spectral resolution**	2 broad-band chann vis: 0.4-1.1 um IR: 10.5-12.5 um
good good	(sea sfc temp) (vegetation index)	marginal N/A
IR yes (10 bit) vis no (pre-launch, drifts)	**absolute calibration**	IR yes (8 bit) vis no (cont. gain adj.
no	**visible-band dynamic range/nighttime operation**	yes
N/A N/A	(auroral characterstics) (global lightning detection) [NASA]	yes good
developmental N/A	(biomass burning) [NESDIS, NASA] (moonlit clouds/snow)	added potential with unique visible band good
no	**coincident passive microwave**	yes
N/A N/A	(snow/ice, rain rate) (sfc. wind, soil moisture)	good good
10	**coincident space environment measurements**	yes
N/A	(auroral image features + electron flux)	yes

From: Greg Scharfen, National Snow and Ice Data Center

DMSP MSWG ARCHIVE RECOMMENDATIONS

The DMSP Mission Sensor Working Group (MSWG) strongly encourages NOAA, through its joint National Geophysical and National Snow and Ice Data Centers, to support the rescue of DMSP Operational Linescan System (OLS) data, to archive the OLS and mission sensor data bases and to provide timely access and services to the DMSP user community. The Working Group considers the complete DMSP data stream from all operational satellites to be an important national resource of climate and space environmental data. At this time, DMSP is the only U.S. or international satellite program to routinely image the Earth's microwave and auroral emissions.

The DMSP Mission Sensor Working Group strongly recommends the following data bases comprise the national archive of DMSP data at NGDC and NSIDC:

1. Visible imagery recorded at 2.7 km resolution. The data base will be organized by scan line with the satellite nadir position identified in space and time. The values will be instrument counts as recorded a AFWGC, which consist of relative radiances with instrumental gains and other corrections applied. All pixels will be geolocatable.

2. Browse images of the visible imagery decimated by about 10 to 1.

3. Infrared imagery recorded at 2.7 km resolution. The data base structure and format will be the same as the 2.7 km visible imagery described in 1.

4. Visible imagery recorded at about 0.5 km resolution. The data base structure will be the same as the 2.7 km data but the format will be different to incorporate the five fold increase in pixels per scan and the decrease from global coverage.

5. Infrared imagery recorded at about 0.5 km resolution. The data base structure and format will be the same as the 0.5 km visible imagery described in 4.

6. Auroral imagery at 2.7 km resolution. This is a subset of the 2.7 km visible imagery recorded during polar nighttime and the data base structure and format will be the same as the 2.7 km visible imagery.

7. SSIES or "in-situ" plasma monitor. For the user community, instrument counts will be converted to geophysical units and the satellite position in space and time will be incorporated from the visible imagery file.

8. SSJ/4 or precipitating ion and electron spectrometer. For the user community, instrument counts will be converted to differential energy fluxes and the satellite position in space and time will be incorporated.

9. SSM/T or microwave sounder. The archive data base will be in antenna temperatures with the calibration file and satellite ephemeris included.

10 SSM/I or microwave imager. The archive data base will consist of antenna temperatures, satellite ephemeris, surface type tag, sensor calibration, and geophysical parameter extraction files.

11. SSM/T-2 or microwave water vapor profiler. The archive data base will be in antenna temperatures with the calibration file and satellite ephemeris included.

12. SSM or triaxial fluxgate magnetometer. The archive data base will be in magnetometer raw data counts and the satellite ephemeris included.

This Working Group also recommends the following procedures:

1. If available in a timely manner, the Data Centers will use the calibration algorithms adopted by the Configuration Control Board,

2. The Data Centers will use the DEF data exchange format to distribute DMSP archival data,

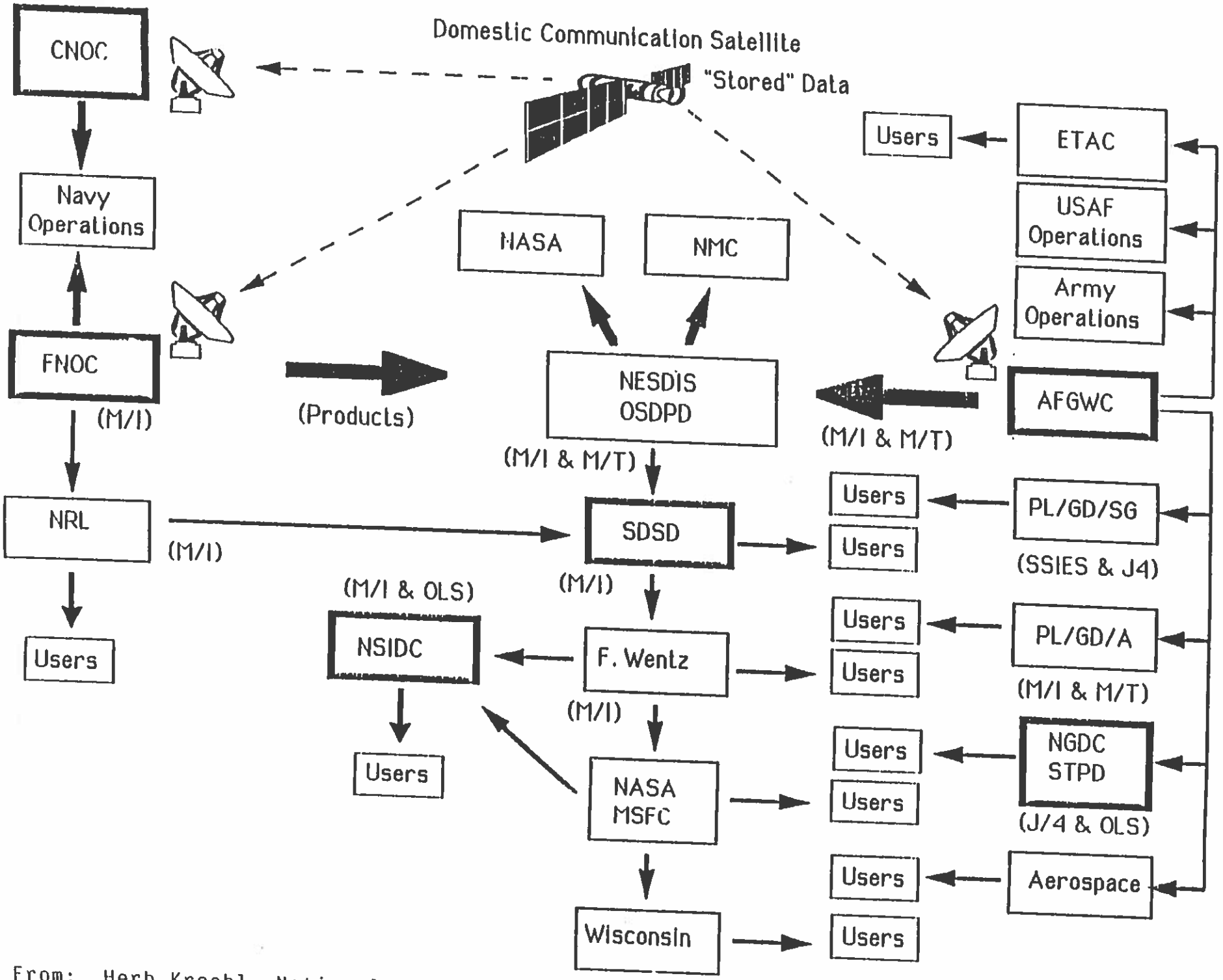
3. After the processing programs are fully operational at the Data Centers, they will distribute the archival data within 4 weeks of reception,

4. This data archival of plan/structure will be distributed to the current principle users and generators of DMSP OLS and mission sensor data.

October 24, 1991

TABLE 1.1: DMSP Satellites and Mission Sensor Complements

Sat	L Time	Begin-End Primary	Mission Sensor Complement
28	0023	24 Mar 72 - 23 Feb 74	SSB
30	0733	8 Nov 72 - 21 Jun 73	SSE, SSJ
29	0730	6 Aug 73 - 24 Jan 77	SSB
31	1148	6 Mar 74 - 27 May 76	SSE, SSL, SSJ/2
32	0701	8 Aug 74 - 22 Nov 74	SSE, IRS, SSJ/2
33	0707	23 May 75 - 30 Nov 77	SSB, IRS, SSJ/2
F-1	1114	11 Sep 76 - 17 Sep 79	OLS, SSH, SSJ/3, SSB
F-2	0730	4 Jun 77 - 19 Mar 80	OLS, SSH, SSJ/3, SSB, SSB/0, IFM, SSI/E, SSI/P
F-3	0639	30 Apr 78 - Dec 79	OLS, SSH, SSJ/3, SSB, GFE-3R
F-4	1003	6 Jun 79 - 29 Aug 80	OLS, SSH, SSJ/3, SSI/E, SSM/T, SSC, SSD
F-6	0614	20 Dec 82 - 24 Aug 87	OLS, SSH-2, SSI/E, SSJ/4, SSB/A
F-7	1010	18 Dec 83 - 17 Oct 87	OLS, SSM/T, SSI/E, SSJ/4, SSB, SSJ*, SSM
F-8	0611	18 Jun 87 - 13 Aug 91	OLS, SSM/I, SSM/T, SSI/ES, SSJ/4, SSB/X-M
F-9	0934	3 Feb 88 -	OLS, SSM/T, SSI/ES, SSJ/4, SSB/X
F-10	2033	1 Dec 90 -	OLS, SSM/I, SSM/T, SSI/ES, SSJ/4, SSB/X-2
F-11	1705	28 Nov 91 -	OLS, SSM/I, SSM/T, SSM/T-2, SSJ/4, SSI/ES-2, SSB/X-2
S-11		TBD	OLS, SSM/I, SSM/T, SSJ/4 SSI/ES-2, SSB/X-2, SSM
S-13		TBD	OLS, SSM/I, SSM/T, SSM/T-2, SSJ/4, SSI/ES-2, SSB/X-2, SSM, SSZ
S-14		TBD	OLS, SSM/I, SSM/T, SSM/T-2, SSJ/4, SSI/ES-2, SSB/X-2, SSM, SSZ
S-15		TBD	OLS, SSM/I, SSM/T, SSM/T-2, SSI/ES-2, SSJ/4, SSB/X-2, SSM, SSF
S-16		TBD	OLS, SSMIS, SSI/ES-2, SSJ/4, SSM, SSF, SSY
S-17		TBD	OLS, SSMIS, SSI/ES-2, SSJ/4, SSM, SSF, SSULI, SSUSI


CNOC
Domestic Communication Satellite
"Stored" Data
Navy Operations
NASA
NMC
Users
ETAC
USAF Operations
Army Operations
FNOC
(M/I)
(Products)
NESDIS OSDPD
(M/I & M/T)
(M/I & M/T)
AFGWC
NRL
(M/I)
SDSD
(M/I)
Users
Users
PL/GD/SG
(SSIES & J4)
Users
(M/I & OLS)
NSIDC
F. Wentz
(M/I)
Users
Users
PL/GD/A
(M/I & M/T)
Users
Users
NGDC STPD
(J/4 & OLS)
NASA MSFC
Users
Users
Aerospace
Wisconsin
Users
Users
From: Herb Kroehl, National Geophysical Data Center