National Aeronautics and Space Administration
Goddard Earth Science
Data Information and Services Center (GES DISC)

README Document for the Nimbus-4 Backscatter Ultraviolet Spectrometer (BUV) Level-1 Dark Current Study Products

BUVN4L1DCM
BUVN4L1DCW

Last Revised 06/22/2017

Goddard Earth Sciences Data and Information Services Center (GES DISC)
http://disc.gsfc.nasa.gov
NASA Goddard Space Flight Center
Code 610.2
Greenbelt, MD 20771 USA

Prepared By:

James E. Johnson	10/28/2015
Name GES DISC GSFC Code 610.2	Date

Reviewed By:

Name	mm/dd/yyyy
Name GSFC Code xxx	Date

Name	mm/dd/yyyy
Name GSFC Code xxx	Date

Goddard Space Flight Center
Greenbelt, Maryland

Revision History

Revision Date	Changes	Author
10/28/2015	Original	James E. Johnson
06/22/2017	Updated URLs in sections 5 and 6	James E. Johnson

Table of Contents

1. Introduction

This document provides basic information on using the old Nimbus-4 Backscatter Ultraviolet Spectrometer (BUV) Level-1 Dark Current Study Master and Working data products.

1.1 Data Product Description

The BUV Dark Current Study products contain the radiances from the Level-1 Radiance or RUT product, geophysical indices and classification, geographic and geomagnetic coordinates, solar magnetic parameters and angles, the monochromator and photometer pulse count and analog data, and energetic trapped particles. Each file typically contains one day of data. There is one-to-one correspondence between the Master and Working data products, the only difference is the Working product contains data from the Master product with filtering applied to it. The data are available from April 10, 1970 (day of year 100) through Dec. 16, 1971 (day of year 350).

These products were previously available from the NASA National Space Science Data Center (NSSDC) under the names BUV Dark Current Study Master Data, with the identifier ESAC-00045, and BUV Dark Current Study Working Data, with the identifier ESAC-00054 (note both used the old id 70-025A-05H).

1.1.1 The Backscatter Ultraviolet Spectrometer

The Backscatter Ultraviolet Spectrometer (BUV) was designed to monitor the vertical distribution and total column amount of atmospheric ozone on a global scale by measuring the intensity of ultraviolet radiation backscattered by the atmosphere in the 250 to 340 nm spectral region. The primary instrumentation consisted of a double monochromator containing all reflective optics and a photomultiplier detector. The double monochromator was composed of two Ebert-Fastie-type monochromators in tandem. Each monochromator had a 52 x 52-mm grating with 2400 lines per mm. Light from a 0.05-sr solid angle (subtending approximately a 222 km^2 area on the earth's surface from a satellite height of approximately 1100 km) entered the nadir-pointing instrument through a depolarizing filter. A motor-driven cam step rotated the gratings to monitor the intensity of 12 ozone absorption wavelengths. The detector was a photomultiplier tube. For background readings, a filter photometer measured the reflected UV radiation in an ozone-free absorption band at 380 nm.

The Nimbus-4 BUV mission was succeeded by the SBUV instrument flown later on the Nimbus-7 satellite, and subsequently the SBUV/2 instruments on a series of NOAA Polar orbiting Operational Environmental satellites. The BUV experiment was successful and returned data from April 10, 1970 through May 6, 1977. The instrument operated mostly continuously until

July 1972 when the Nimbus-4 spacecraft solar array partially failed. After this time data collection had to be curtailed, particularly in the later years.

The original principal investigator for the BUV experiment was Dr.Donald F. Heath.

1.1.2 Nimbus-4 Overview

The Nimbus-4 satellite was successfully launched on April 8, 1970. The spacecraft included nine experiments: (1) an Image Dissector Camera System (IDCS) for providing daytime cloud cover pictures, both in real-time and recorded modes (2) a Temperature-Humidity Infrared Radiometer (THIR) for measuring daytime and nighttime surface and cloudtop temperatures, as well as the water vapor content of the upper atmosphere, (3) an Backscatter Ultraviolet Spectrometer (BUV) for measuring the emission spectra of the earth/atmosphere system, (4) a Satellite Infrared Spectrometer (SIRS) for determining the vertical profiles of temperature and water vapor in the atmosphere, (5) a Monitor of Ultraviolet Solar Energy (MUSE) for detecting solar UV radiation, (6) a Backscatter Ultraviolet (BUV) detector for monitoring the vertical distribution and total amount of atmospheric ozone on a global scale, (7) a Filter Wedge Spectrometer (FWS) for accurate measurement of IR radiance as a function of wavelength from the earth/atmosphere system, (8) a Selective Chopper Radiometer (SCR) for determining the temperatures of six successive 10-km layers in the atmosphere from absorption measurements in the 15-micrometer CO_2 band, and (9) an Interrogation, Recording, and Location System (IRLS) for locating, interrogating, recording, and retransmitting meteorological and geophysical data from remote collection stations.

The orbit of the satellite can be characterized by the following:

- circular orbit at 1100 km
- inclination of 80 degrees
- period of an orbit is about 107 minutes
- orbits cross the equator at 26 degrees of longitude separation
- sun-synchronous

1.2 Algorithm Background

The Nimbus-4 BUV data were generated from the spacecraft telemetry, attitude and orbital data. The data were originally processed on IBM 360 computers using a 32-bit architecture. The radiances at 12 wavelengths for the monochromator and photometer are from the BUV Level-1 RUT data product. Further information on the BUV data processing can be found in the Nimbus-4 Users' Guide Section 7 and BUV Dark Current Study documents.

1.3 Data Disclaimer

The data should be used with care and one should first read the Nimbus-4 BUV Dark Current Study document, as well as the Nimbus-4 User's Guide, section 7 describing the BUV experiment. Users should cite this data product in their research.

2. Data Organization

The Nimbus-4 Backscatter Ultraviolet Spectrometer Level-1 Dark Current Study data products span the time period from April 10, 1970 to Dec. 16, 1971. Each file typically contains one day of data.

2.1 File Naming Convention

The data product files are named according to the following convention:

<Platform>-<Instrument>_<Level>-<Type>_<Date>_<Tape>.<Suffix>

where:

- Instrument = name of the instrument (always BUV)
- Platform = name of the platform or satellite (always Nimbus4)
- Level = processing level of data (always L1)
- Type = the data type indentifier (either DCM for Master or DCW for Working)
- Date = Data start date in format <YYYY>m<MMDD> where
    1. YYYY = 4 digit year (1970 or 1971)
    2. MM = 2 digit month (01-12)
    3. DD = 2 digit day of month (01-31)
- Tape = tape number (DR primary tape, DS backup tape plus a 4 digit number)
- Suffix = the file format (always TAP, indicating tape binary data)

`File name example: Nimbus4-BUV_L1-DCM_1970m0430_DR3643.TAP`

2.2 File Format and Structure

The data are stored as they were originally written in IBM binary (big-endian) record oriented structured files. The files were written on the original 1600 bpi 9-track tapes using a FORTRAN block format, each with up to 25 560 byte (140 4-byte words) records. All data records are identical, and data variables are grouped into 10 sections containing the radiances, geographic, geomagnetic and other information (see chapter 3 below).

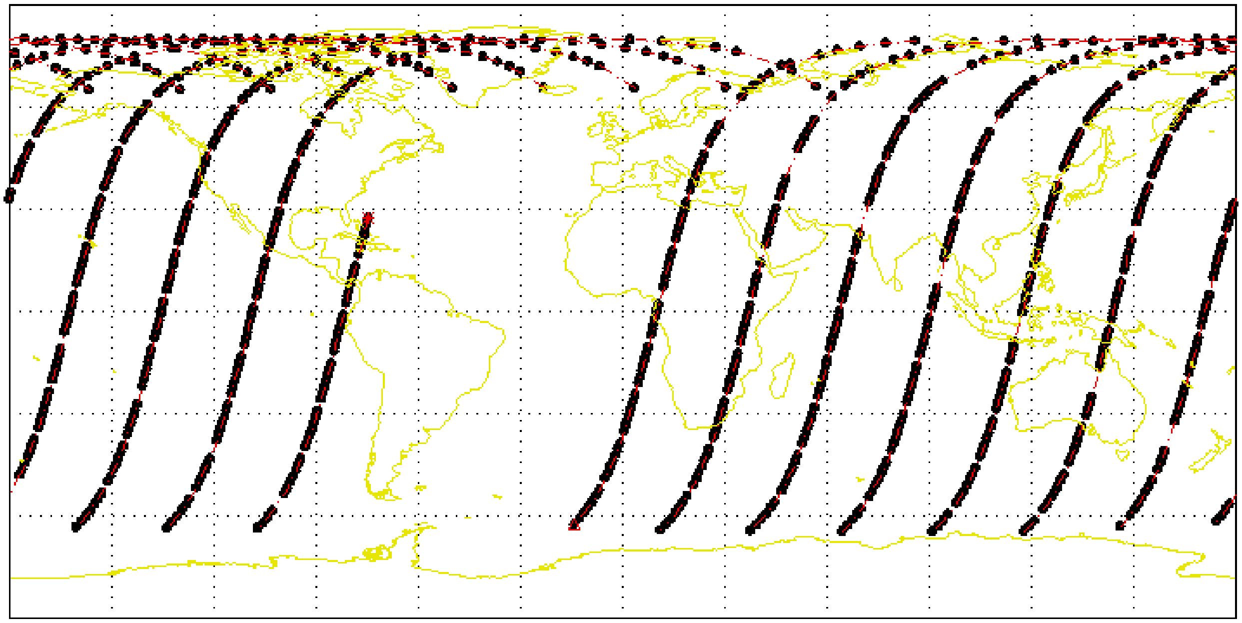
2.3 Key Science Data Fields

The primary science data fields in this data product are the dark current radiances from the photometer and monochromator for a full day (from the nighttime/descending orbit side).

.

Figure 1: Typical data coverage for a Nimbus-4 BUV Level-1 Dark Current Study file.

Nimbus-4 BUV Day: 1971/001 – 05:05:41Z



3. Data Contents

The granularity of this data collection is one day.

3.1 Data Records

Each Level-1 Dark Current Study data record is 560 bytes (140 4-byte words). See the Nimbus-4 BUV Dark Current Study document for a more detailed description. A sample FORTRAN program to read the data files can be found in the Appendix.

Table 3-1-1: Data Record

	Word	Type	Variable	Description/Comments
Selection Parameters	1	I*4	MODE	0 =Data (Acquisition) 1 =MCSA (Calibration)
	2	I*4	INOUT	1 = inside energetic proton and electron trapping region ($1 < L < 4$) 2 = inside electron trapping region only ($4 \le L < 12$) 3= External ($L \ge 12$)
	3	I*4	NTD	1 = Night 2 = Twilight 3 = Day
	4	I*4	ID	Single Index for (INOUT, NTD) 1 = (1,1) 4 = (2,1) 7 = (3,1) 2 = (1,2) 5 = (2,2) 8 = (3,2) 3 = (1,3) 6 = (2,3) 9 = (3,3)
	5-28	24 I*4	NG(I,J)	0 = Low Gain I = Channel 1-12 1 = High Gain J = 1 Monochromator / 2=Photometer
Mapping & Ordering	29	I*4	MEGC	Matrix Element, Geocentric Coordinates
	30	I*4	MEBL	Matrix Element, BL Space
	31	I*4	LTVE	Local Time Vector Element
	32	I*4	MLTVE	Magnetic Local Time Vector Element
Geophysical Indices and Classification	33	I*4	NDST	D_{st} Magnetic Activity Index (Hourly)
	34	I*4	NAE	AE Auroral Electrojet (Hourly)
	35	I*4	NAP	Daily A_p Index
	36	R*4	TEN7	Daily Ottawa 2800 MHz (10.7 cm) Solar Flux Index
	37	I*4	KDST	Range Index for D_{st} (1 = maximum; 2 = minimum; 3 = intermediate)
	38	I*4	KAE	Range Index for AE (1 = maximum; 2 = minimum; 3 = intermediate)
	39	I*4	KAP	Range Index for A_p (1 = maximum; 2 = minimum; 3 = intermediate)
	40	I*4	KTEN7	Range Index for 10.7 cm solar flux (1=maximum; 2=minimum; 3=intermediate)

Dates and Times of Measurements	41	I*4	JYR	Calendar Year Data were Gathered
	42	I*4	JDAYS	Julian Day at Start of Scan
	43	R*4	HRS	Universal Time at Start of Scan in Hours
	44	R*4	SECS	Universal Time at Start of Scan in Seconds
	45	I*4	JDAYE	Julian Day at End of Scan
	46	R*4	HRE	Universal Time at End of Scan in Hours
	47	R*4	SECE	Universal Time at End of Scan in Seconds
	48	R*4	XLTS	Local Time at Start of Scan
	49	R*4	GMLTS	Geomagnetic Local Time at Start of Scan
Geographic and Magnetic Coordinates	50	R*4	GDLATS	Geodetic Latitude at Start of Scan in Degrees (-90 to +90)
	51	R*4	GDLONS	Geodetic Longitude at Start of Scan in Degrees (-180 to +180)
	52	R*4	ALTS	Altitude at Start of Scan in km
	53	R*4	GCLATS	Geocentric Latitude at Start of Scan in Degrees (-90 to +90)
	54	R*4	RKMS	Radial Distance to Satellite Position at Start of Scan in km
	55	R*4	GMLATS	Geomagnetic Latitude at Start of Scan in Degrees
	56	R*4	GMLONS	Geomagnetic Longitude at Start of Scan in Degrees
	57	R*4	B	Magnetic Field Intensity at Start of Scan in Gauss
	58	R*4	XL	Magnetic Shell Parameter at Start of Scan in Earth Radii
Solar Magnetic Parameters and Angles	59	R*4	SDEC	Sun Declination in Degrees
	60	R*4	GSHA	Greenwich Solar Hour Angle in Hours
	61	R*4	TILT	Tilt of Dipole Axis in Degrees
	62	R*4	SMHA	Solar Magnetic Hour Angle in Hours
	63	R*4	SMLON	Solar Magnetic Longitude in Degrees
	64	R*4	SOLSEC	Solar Sector
	65	R*4	SZEN	Solar Zenith Angle at Start of Scan in Degrees
	66	R*4	SAZ	Solar Azimuth Angle at Start of Scan in Degrees
	67	R*4	VASP	Spare for Future Use (set to 0.0)

Counts	68-79	12 R*4	DATA(I,1)	Monochromator Pulse Counts; I = Channels 1-12
	80-91	12 R*4	DATA(I,2)	Photometer Pulse Counts; I = Channels 1-12
Analog	92-103	12 R*4	U(I,1)	Monochromator Analog Data; I = Channels 1-12
	104-115	12 R*4	U(I,2)	Photometer Analog Data; I = Channels 1-12
Energetic Particles	116-121	6 R*4	ENR(I)	Energetic Particle Counts
	122-126	5 R*4	ETN(I)	Integral Electron Fluxes at E > 1,2,3,4,5 MeV
	127-131	5 R*4	PTN(I)	Integral Proton Fluxes at E > 10,20,30,50,100 MeV
U-Tape Info	132-138	7 R*4	SPARE(I)	Seven Spare Words (set to 0.0)
	139	I*4	NFOLD	File Number from U-Tape
	140	I*4	FROLD	Record Number from U-Tape

3.2 Metadata

The metadata are contained in a separate XML formatted file having the same name as the data file with .xml appended to it.

Table 3-2: Metadata attributes associated with the data file.

Name	Description
LongName	Long name of the data product.
ShortName	Short name of the data product.
VersionID	Product or collection version.
GranuleID	Granule identifier, i.e. the name of the file.
Format	File format of the data file.
CheckSumType	Type of checksum used.
CheckSumValue	The value of the calculated checksum.
SizeBytesDataGranule	Size of the file or granule in bytes.
InsertDateTime	Date and time when the granule was inserted into the archive. The format for date is YYYY-MM-DD and time is hh-mm-ss.
ProductionDateTime	Date and time the file was produced in format YYYY-MM-DDThh:mm:ss.ssssssZ
RangeBeginningDate	Begin date when the data was collected in YYYY-MM-DD format.
RangeBeginningTime	Begin time of the date when the data was collected in hh-mm-ss format.
RangeEndingDate	End date when the data was collected in YYYY-MM-DD format.
RangeEndingTime	End time of the date when the data was collected in hh-mm-ss format.
WestBounding Coordinate	The westernmost longitude of the bounding rectangle(-180.0 to +180.0)
NorthBounding Coordinate	The northernmost latitude of the bounding rectangle(-90.0 to +90.0)
EastBounding Coordinate	The easternmost longitude of the bounding rectangle(-180.0 to +180.0)
SoutthBounding Coordinate	The southernmost latitude of the bounding rectangle (-90.0 to +90.0)

PlatformShortName	Short name or acronym of the platform or satellite
InstrumentShortName	Short name or acronym of the instrument
SensorShortName	Short name or acronym of the sensor
Elapsed_Min_Time	Duration in minutes of data collected during an orbit

4. Reading the Data

The data are written in a binary record-oriented format. Using the record format specification in the section above, users can write software to read the data files. Please note that the data were originally written using a big-endian format, therefore users on little-endian machines will need to swap bytes for the words. Also, the floating point data were written using IBM 360 machines, and must be converted if reading on a machine that understands IEEE floats (integers are not affected).

A sample FORTRAN program is included in the Appendix section which will read the data files. Additionally three FORTRAN functions are included to perform byte swapping, and conversion from IBM float to IEEE float.

5. Data Services

5.1 GES DISC Search

The GES DISC provides a keyword, spatial, temporal and advanced (event) searches through its unified search and download interface:

https://disc.gsfc.nasa.gov/

5.2 Documentation

The data product landing pages provide information about these data products, as well as links to download the data files and relevant documentation:

https://disc.gsfc.nasa.gov/datacollection/BUVN4L1DCM_001.html

https://disc.gsfc.nasa.gov/datacollection/BUVN4L1DCW_001.html

5.3 Direct Download

These data products are available for users to download directly using HTTPS:

https://acdisc.gesdisc.eosdis.nasa.gov/data/Nimbus4_BUV_Level1/BUVN4L1DCM.001/

https://acdisc.gesdisc.eosdis.nasa.gov/data/Nimbus4_BUV_Level1/BUVN4L1DCW.001/

6. More Information

6.1 Contact Information

Name: GES DISC Help Desk
URL: https://disc.gsfc.nasa.gov/
E-mail: gsfc-help-disc@lists.nasa.gov
Phone: 301-614-5224
Fax: 301-614-5228
Address: Goddard Earth Sciences Data and Information Services Center
Attn: Help Desk
Code 610.2
NASA Goddard Space Flight Center
Greenbelt, MD 20771, USA

6.2 References

D. F. Heath, and A. J. Kruger, "The Nimbus-4 User's Guide - Section 7: The Backscatter Ultraviolet Spectrometer (BUV) Experiment", NASA Goddard Space Flight Center, March 1970, Pages 149-172

Stassinopoulos et al., "Nimbus-4 BUV Dark Current Study: Data Filtering", NASA Goddard Space Flight Center, NASA X-601-78-21, June 1978

7. Appendices

Acknowledgements

The Nimbus data recovery task at the GES DISC is funded by NASA's Earth Science Data and Information System program.

Acronyms

EOS: Earth Observing System

ESDIS: Earth Science and Data Information System

GES DISC: Goddard Earth Sciences Data and Information Services Center

GSFC: Goddard Space Flight Center

BUV: Backscatter Ultraviolet Spectrometer

RUT: Radiance U-Tape Data Product

L1: Level-1 Data

NASA: National Aeronautics and Space Administration

QA: Quality Assessment

U-Values: Radiance in resolution units of the digitizer

UT: Universal Time

FORTRAN Code

```
C-----------------------------------------------------------------------
C ^NAME: READ_BUV_DCS
C
C ^DESCRIPTION:
C     This program opens and reads a Nimbus-4 BUV level-1 Dark Current Study
C     (Master or Working) data file and prints the contents of the file to
C     the screen. Files are blocked up to 25 records, each of size 560 bytes
C     (140 4-byte words). See the Nimbus-4 BUV Dark Current Study document
C     which gives the product file specification.
C
C ^MAJOR VARIABLES:
C     FNAME  - name of input file
C
C ^NOTES:
C     Compile: gfortran -frecord-marker=4 -o READ_BUV_DCS.EXE READ_BUV_DCS.FOR
C
C ^ORGANIZATION: NASA/GSFC, Code 610.2
C
C ^AUTHOR:  James Johnson
C
C ^ADDRESS: james.johnson@nasa.gov
C
C ^CREATED: October 22, 2015
C-----------------------------------------------------------------------

      CHARACTER    FNAME*1024          ! Name of input file
      CHARACTER    BLOCK(25*140*4)     ! Blocks are up to 25x140x4-byte records
      CHARACTER    BUFF(4)             ! Buffer to hold 4-byte word
      INTEGER*4    WORD                ! 4-byte word
      INTEGER*4    BLKSIZ              ! Block size header
      EQUIVALENCE  (BUFF, WORD)

C     Get the name of the input data file to read
      PRINT *, 'Enter the name of the input file:'
      READ (5,'(A)') FNAME

C     Open the specified input file
      OPEN (UNIT=1, FILE=FNAME, STATUS='OLD', ACCESS='DIRECT',
     &      FORM='UNFORMATTED', RECL=1, ERR=99, IOSTAT=IOS)

C     Initialize M (block number), N (record number) and IOFF (byte offset)
      M=1
      N=0
      IOFF=0

C     Loop through the file reading all blocks of data
   10 DO

C       Read first 4-byte word or block size
        DO I=1,4
          READ (1, REC=I+IOFF, ERR=91, IOSTAT=IOS) BUFF(I)
        END DO
        IOFF = I+IOFF-1
        BLKSIZ = WORD
```

```
        IF (BLKSIZ .GT. 0) THEN

C       Next read the block of data records
          DO I=1,BLKSIZ
            READ (1, REC=I+IOFF, ERR=92, IOSTAT=IOS) BLOCK(I)
          END DO
          IOFF=I+IOFF-1
          CALL PRDREC(BLOCK, BLKSIZ, N)

        END IF

C       Finally read last 4-byte word (should match first block size)
        DO I=1,4
          READ (1, REC=I+IOFF, ERR=93, IOSTAT=IOS) BUFF(I)
        END DO
        IOFF=I+IOFF-1

        IF (BLKSIZ .NE. WORD) THEN
          PRINT '("BLKSIZ: ",I10," != ",I10)', BLKSIZ, WORD
        END IF

C       END OF FILE MARKER
        IF (BLKSIZ .EQ. 0 .AND. WORD .EQ. 0) GOTO 90

        M=M+1

      END DO

C     Close the input file
   90 CLOSE(1)
      GOTO 100
   91 PRINT '("ERROR: READ FIRST WORD, IOSTAT: ",I5)', IOS
      GOTO 100
   92 PRINT '("ERROR: READ BLOCK ",I4,", IOSTAT: ",I5)', N, IOS
      GOTO 100
   93 PRINT '("ERROR: READ LAST WORD, IOSTAT = ",I5)', IOS
      GOTO 100
   99 PRINT '("ERROR: OPENING FILE, IOSTAT: ",I6)', IOS

  100 STOP
      END
```

```
C-----------------------------------------------------------------------
C ^SUBROUTINE: PRDREC
C
C     This subroutine will extract and print the data records to the screen
C-----------------------------------------------------------------------

      SUBROUTINE PRDREC(BLOCK, IBLKSZ, N)

      INTEGER*4    BLOCK(25*140/4)     ! Blocks are up to 25 140 word records
      INTEGER*4    IREC(140)           ! Record is 140 4-byte words

      NRECS = IBLKSZ/140/4

      DO I=1,NRECS

        N=N+1
        IREC = BLOCK((I-1)*140+1:I*140)
        PRINT '("DATA RECORD: ",I6)', N

C       Group 1: Selection Parameters
        PRINT '("MODE    = ",X,I3)', I4SWAP(IREC(1))
        PRINT '("INOUT   = ",X,I3)', I4SWAP(IREC(2))
        PRINT '("NTD     = ",X,I3)', I4SWAP(IREC(3))
        PRINT '("ID      = ",X,I3)', I4SWAP(IREC(4))
        PRINT '("NG(1,*) = ",12(X,I3))',(I4SWAP(IREC((J-1)+5)),J=1,12)
        PRINT '("NG(2,*) = ",12(X,I3))',(I4SWAP(IREC((J-1)+17)),J=1,12)

C       Group 2: Mapping & Ordering Indices
        PRINT '("MEGC    = ",X,I11)', I4SWAP(IREC(29))
        PRINT '("MEBL    = ",X,I11)', I4SWAP(IREC(30))
        PRINT '("LTVE    = ",X,I11)', I4SWAP(IREC(31))
        PRINT '("MLTVE   = ",X,I11)', I4SWAP(IREC(32))

C       Group 3: Geophysical Indices and Classification
        PRINT '("NDST    = ",X,I11)', I4SWAP(IREC(33))
        PRINT '("NAE     = ",X,I11)', I4SWAP(IREC(34))
        PRINT '("NAP     = ",X,I11)', I4SWAP(IREC(35))
        PRINT '("TEN7    = ",G12.6)', R4IBM(I4SWAP(IREC(36)))
        PRINT '("KDST    = ",X,I3)', I4SWAP(IREC(37))
        PRINT '("KAE     = ",X,I3)', I4SWAP(IREC(38))
        PRINT '("KAP     = ",X,I3)', I4SWAP(IREC(39))
        PRINT '("KTEN7   = ",X,I3)', I4SWAP(IREC(40))

C       Group 4: Dates and Times of Measurements
        PRINT '("JYR     = ",X,I11)', I4SWAP(IREC(41))
        PRINT '("JDAYS   = ",X,I11)', I4SWAP(IREC(42))
        PRINT '("HRS     = ",G12.6)', R4IBM(I4SWAP(IREC(43)))
        PRINT '("SECS    = ",G12.6)', R4IBM(I4SWAP(IREC(44)))
        PRINT '("JDAYE   = ",X,I11)', I4SWAP(IREC(45))
        PRINT '("HRE     = ",G12.6)', R4IBM(I4SWAP(IREC(46)))
        PRINT '("SECE    = ",G12.6)', R4IBM(I4SWAP(IREC(47)))
        PRINT '("XLTS    = ",G12.6)', R4IBM(I4SWAP(IREC(48)))
        PRINT '("GMLTS   = ",G12.6)', R4IBM(I4SWAP(IREC(49)))

C       Group 5: Positional Coordinates in Geographic and Magnetic Space
        PRINT '("GDLATS  = ",G12.6)', R4IBM(I4SWAP(IREC(50)))
        PRINT '("GDLONS  = ",G12.6)', R4IBM(I4SWAP(IREC(51)))
        PRINT '("ALTS    = ",G12.6)', R4IBM(I4SWAP(IREC(52)))
        PRINT '("GCLATS  = ",G12.6)', R4IBM(I4SWAP(IREC(53)))
        PRINT '("RKMS    = ",G12.6)', R4IBM(I4SWAP(IREC(54)))
        PRINT '("GMLATS  = ",G12.6)', R4IBM(I4SWAP(IREC(55)))
        PRINT '("GMLONS  = ",G12.6)', R4IBM(I4SWAP(IREC(56)))
        PRINT '("B       = ",G12.6)', R4IBM(I4SWAP(IREC(57)))
        PRINT '("XL      = ",G12.6)', R4IBM(I4SWAP(IREC(58)))
```

```
C       Group 6: Solar Magnetic Parameters and Angles
        PRINT '("SDEC    = ",G12.6)', R4IBM(I4SWAP(IREC(59)))
        PRINT '("GSHA    = ",G12.6)', R4IBM(I4SWAP(IREC(60)))
        PRINT '("TILT    = ",G12.6)', R4IBM(I4SWAP(IREC(61)))
        PRINT '("SMHA    = ",G12.6)', R4IBM(I4SWAP(IREC(62)))
        PRINT '("SMLON   = ",G12.6)', R4IBM(I4SWAP(IREC(63)))
        PRINT '("SOLSEC  = ",G12.6)', R4IBM(I4SWAP(IREC(64)))
        PRINT '("SZEN    = ",G12.6)', R4IBM(I4SWAP(IREC(65)))
        PRINT '("SAZ     = ",G12.6)', R4IBM(I4SWAP(IREC(66)))
        PRINT '("VASP    = ",G12.6)', R4IBM(I4SWAP(IREC(67)))

C       Group 7: Pulse Count Data
        PRINT '("DAT(*,1)= ",/,6(X,G12.6))',
     &    (R4IBM(I4SWAP(IREC((J-1)+68))),J=1,12)
        PRINT '("DAT(*,2)= ",/,6(X,G12.6))',
     &    (R4IBM(I4SWAP(IREC((J-1)+80))),J=1,12)

C       Group 8: Analog Data
        PRINT '("U(*,1)  = ",/,6(X,G12.6))',
     &    (R4IBM(I4SWAP(IREC((J-1)+92))),J=1,12)
        PRINT '("U(*,2)  = ",/,6(X,G12.6))',
     &    (R4IBM(I4SWAP(IREC((J-1)+104))),J=1,12)

C       Group 9: Energetic Trapped Particles
        PRINT '("ETR     = ",/,6(X,G12.6))',
     &    (R4IBM(I4SWAP(IREC((J-1)+116))),J=1,6)
        PRINT '("ETN     = ",/,5(X,G12.6))',
     &    (R4IBM(I4SWAP(IREC((J-1)+122))),J=1,5)
        PRINT '("PTN     = ",/,5(X,G12.6))',
     &    (R4IBM(I4SWAP(IREC((J-1)+127))),J=1,5)

C       Group 10: U-Tape Files, Records & Spares
        PRINT '("SPARES  = ",7(X,F6.1))',
     &    (R4IBM(I4SWAP(IREC((J-1)+132))),J=1,7)
        PRINT '("NFOLD   = ",X,I11)', I4SWAP(IREC(139))
        PRINT '("NROLD   = ",X,I11)', I4SWAP(IREC(140))
        PRINT '("")'

      END DO

      RETURN
      END
```

```
C----------------------------------------------------------------------
C ^FUNCTION: I4SWAP
C
C     This subroutine will swap the bytes of a 4-byte data element
C----------------------------------------------------------------------

      FUNCTION I4SWAP(INPUT)

      INTEGER*4          IWORD          ! Input 4-byte word
      INTEGER*4          IDROW          ! Byte-swapped 4-byte word
      CHARACTER          DATBUF(4)      ! Input data buffer
      CHARACTER          SWPBUF(4)      ! Output swapped buffer
      EQUIVALENCE        (IWORD, DATBUF)
      EQUIVALENCE        (IDROW, SWPBUF)

      IWORD = INPUT
      DO 10 K=1,4
        SWPBUF(K) = DATBUF(4-K+1)
   10 CONTINUE
      I4SWAP = IDROW

      RETURN
      END

C----------------------------------------------------------------------
C ^FUNCTION: R4IBM
C
C     This function will convert an input word to an IBM float
C----------------------------------------------------------------------

      FUNCTION R4IBM(IWORD)

      INTEGER*4      IDROW              ! reverse the bits of input word
      REAL*8         A /16.0/           ! base number
      INTEGER*4      B /64/             ! exponent offset
      REAL*8         C /0.0/            ! fraction offset
      INTEGER*1      S                  ! sign flag
      INTEGER*2      E                  ! binary exponent
      REAL*8         F                  ! binary fraction
      REAL*8         M                  ! mantissa
      REAL*8         V                  ! float value
      INTEGER*4      I                  ! counter

      S = ISHFT(IWORD, -31)

      E = 0
      DO 10 I=0,6
        E = E + IAND(ISHFT(IWORD,-24),ISHFT(1,I))
   10 END DO

      IDROW = 0
      DO 11 I=0,31
        IF (IAND(IWORD,ISHFT(1,I)) .NE. 0) THEN
          IDROW = IOR(IDROW,(ISHFT(1,31-I)))
        END IF
   11 END DO

      F = 0.0
      DO 12 I=0,31
        IF (ISHFT(IAND(ISHFT(IDROW,-8),ISHFT(1,I)),1) .NE. 0) THEN
          F = F + 1 / FLOAT(ISHFT(IAND(ISHFT(IDROW,-8),ISHFT(1,I)),1))
        END IF
   12 END DO
```

```
M = C + F                           ! calculate the mantissa
V = (-1)**S * M * A**(E - B)        ! calculate the float value
IF (ABS(V) .LT. 2.0**(-149)) THEN
  V = (-1)**S * 0.0                 ! avoid underflow
END IF

R4IBM = V
RETURN
END
```