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

README Document for the Nimbus-5 Nimbus-E Microwave Spectrometer (NEMS) Level 2 Output Data

NEMSN5L2

Last Revised 12/18/2020

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

Prepared By:

James E. Johnson	12/18/2020
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

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12/18/2020	Original	James E. Johnson

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1. Introduction

This document provides basic information on using the Nimbus-E Microwave Spectrometer (NEMS) Level 2 Output Data product.

1.1 Data Product Description

The Nimbus-E Microwave Spectrometer (NEMS) Level-2 Output Data product contains surface reflectivity, water vapor, liquid water, thickness, temperature at standard pressure levels, surface brightness temperature, and surface type information, as well as the input antenna and brightness temperatures at 5 microwave channels. The data were originally created on IBM 360/165 computers and copied to 1600 bpi 9-track magnetic tapes. The data are grouped into 16-second, earth-viewing frames. National Meteorological Center (NMC) grid data, interpolated in time and space to the NEMS measurement point, are sometimes included.

The data are available for the time period from 17 December 1972 to 31 October 1973. Each data file contains about 3-7 days worth of data. The principal investigators for the NEMS experiment was Prof. David H. Staelin from MIT.

This product was previously available from the NASA National Space Science Data Center (NSSDC) under the name Microwave Spectrometer Output Files (NEMSOT) with the identifier ESAD-00129 (old id 72-097A-03A).

1.1.1 The Nimbus-E Microwave Spectrometer

The Nimbus E Microwave Spectrometer (NEMS) was designed primarily to demonstrate the capabilities and limitations of microwave sensors for measuring tropospheric temperature profiles, water vapor abundances, cloud liquid water content, and earth surface temperatures. The NEMS continuously monitored microwave radiation at frequencies of 22.235 and 31.4 GHz (H_2O channels), and 53.65, 54.9 and 58.8 GHz (O_2 channels) in the nadir. The three channels near the 5-mm oxygen (O_2) absorption band were used primarily to determine the atmospheric temperature profiles. NEMS provided measurements even in cloud cover conditions that normally restrict the usefulness of conventional IR data in such situations. The two water vapor (H_2O) channels near 10 mm permitted the water vapor and cloud liquid water content over oceans to be estimated and also to yield an estimated temperature once the surface emissivity had been calibrated by comparison with direct measurements. The NEMS viewed footprint is a 180-km diameter circle on the earth's surface.

Data are available for the time period from 1972-12-17 to 1973-10-31. An advanced version of this instrument, the Scanning Microwave Spectrometer (SCAMS), was flown on the subsequent Nimbus 6 satellite.

1.1.2 Nimbus-5 Overview

The Nimbus 5 satellite was successfully launched on December 11, 1972. The primary experiments included: (1) a Temperature-Humidity Infrared Radiometer (THIR) for measuring day and night surface and cloud top temperatures, as well as the water vapor content of the upper atmosphere, (2) an Electrically Scanning Microwave Radiometer (ESMR) for mapping the microwave radiation from the Earth's surface and atmosphere, (3) an Nimbus-E Microwave Spectrometer (NEMS) for obtaining vertical profiles of temperature and moisture, (4) the Nimbus-E Microwave Spectrometer (NEMS) for determining tropospheric temperature profiles, atmospheric water vapor abundances, and cloud liquid water contents, (5) a Selective Chopper Radiometer (SCR) for observing the global temperature structure of the atmosphere, and (6) a Surface Composition Mapping Radiometer (SCMR) for measuring the differences in the thermal emission characteristics of the Earth's surface.

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

- circular orbit at 1100 km
- inclination of 99.9 degrees
- period of an orbit is about 107.2 minutes
- orbits cross the equator at 26 degrees of longitude separation
- sun-synchronous

1.2 Algorithm Background

The Nimbus-5 NEMS data were generated from the spacecraft telemetry, attitude and orbital data. The data were originally processed on IBM 370/165 computers, and copied to 1600 bpi 9-track tapes for archival. Further information on the NEMS instrument and data processing can be found in the Nimbus-5 Users' Guide Section 7.

1.3 Data Disclaimer

The data should be used with care and one should first read the Nimbus-5 User's Guide, Section 7 describing the NEMS experiment. Users should cite this data product in their research:

Staelin, David H. (2020), NEMS/Nimbus-5 Level 2 Output Data V001, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: **[*Data Access Date*]**, https://doi.org/10.5067/4SN4932GXC8R

2. Data Organization

The Nimbus-E Microwave Spectrometer (NEMS) Level-2 Output Data spans the time period from December 17, 1972 to October 31, 1973. A file typically contains about 3-7 days worth of data.

2.1 File Naming Convention

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

<Platform>-<Instrument>_<Level>_<DateTime>_<TapeNumber>.<Suffix>, where

o Platform = name of the platform or satellite (Nimbus5)
o) Instrument = name of the instrument and product (NEMS)
o) Level = process level (L2)
o) Date = Data start date in format <YYYY>m<MMDD> where

1. YYYY = 4 digit year (1972 – 1973)
2. MM = 2 digit month (01 - 12)
3. DD = 2 digit day of month (01 - 31)
4. hh = 2 digit hour of day (00 - 23)
5. mm = 2 digit minute of hour (00 – 59)
6. ss = 2 digit second of minute (00 - 59)

o TapeNumber = 2 digit number of tape (preceded by 'DR' - primary or 'DS' - backup)
o Suffix = the file format (always TAP, indicating tape binary data)

```
File name example: Nimbus5-NEMS_L2_1972m1217t011144_DR24.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 blocked FORTRAN format. Each tape has about 8 files on it, with each file containing about 3-7 days worth of data. Each data file on the tape contains a set of data records with a FORTRAN record size word, the record block, and a FORTRAN record trailing size word.

Each data record in a file is 11,624 bytes in size. Files end with a single End-of-File word, the last file on the tape is followed by a double End-of-File word. Each record block contains the data for a NEMS calibration cycle, which normally consists of 16 major frames, the first 14 of these are Earth viewing data, and the last two contain the cold-load and ambient-load calibration information. The data are written in big-endian IBM 16-bit or 32-bit integers, or IBM 32-bit floats. For the contents and layout of the data, see section 3.1.

During data recovery there were two sets of thirty-one tapes, each containing 8 or 7 files. The first set of tapes are the primary tapes and designated with a DR. The second set are the backup tapes

which are designated with a DS. The DR and DS tape files are for the most part are all identical, except four files on the DS backup tapes were each missing one data record compared to the counterpart on the primary tape. Therefore the 31 files from the primary DR tapes represent the complete record of the NEMS Level 2 data collection and are publicly available at the GES DISC.

2.3 Key Science Data Fields

The primary science data fields are atmospheric temperature, water vapor, liquid water, surface reflectivity, layer thickness, and surface brightness temperature.

Figure 1: Data coverage for a NEMS Level 2 data file showing integrated water vapor.

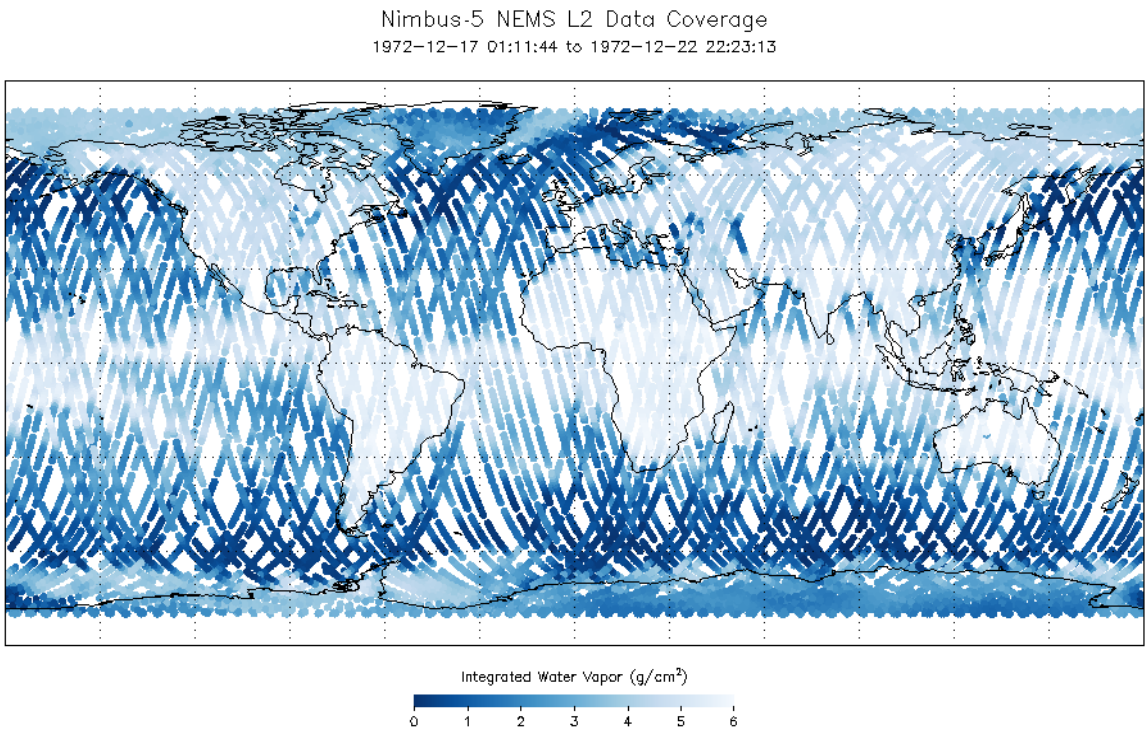
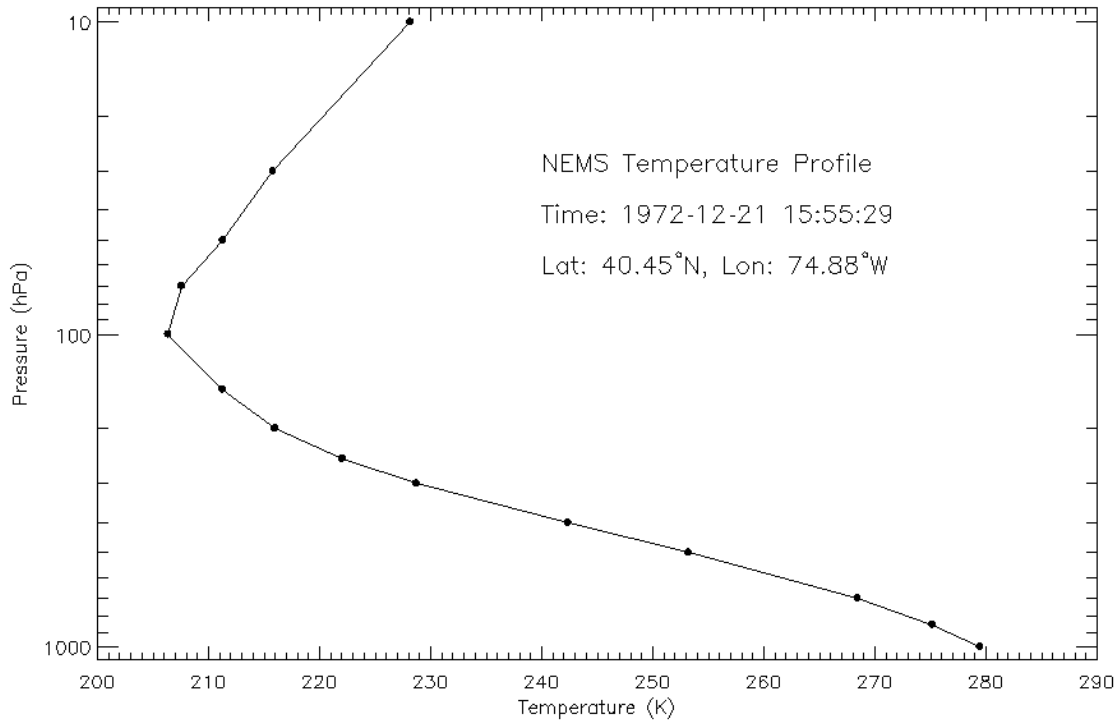


Figure 2: NEMS Level 2 atmospheric temperature profile



3. Data Contents

The granularity for the NEMS data is the entire mission with daily resolution.

3.1 Data Records

The Nimbus-5 User's Guide does not describe the NEMS file format. Refer instead to the 9 page "Format of Stacked NEMS Scan Data" document for the file format.

The original tapes contain data files that have between 3 and 7 days worth of data, with each day containing ~14 orbits. Each 11,624 byte data record contains the data for a NEMS calibration cycle, which consists of 16 major frames. Data were written as IBM big-endian 16-bit integers, 32 bit integers, or 32-bit floats. There are 31 data files for the entire mission spanning the 10 ½ month time period from December 17, 1972 to October 31, 1973

Table 3-1: NEMS Output Data Record Format

Byte	Array Name	Type	Size
1-4	Block Descriptor (Record Size)	INT*4	1
5-8	Segment Descriptor (Record Size – 4)	INT*4	1
9-1448	ITNEMS – Uncalibrated Antenna Temperature Counts (5 channels per measurement per frame)	INT*2	5x8x18
1449-2888	IHNEMS – Housekeeping Parameters for ITNEMS (40 items per frame)	INT*2	40x18
2889-3848	HDRMJF – Major Frame Header (30 items per frame)	INT*2	30x16
3849-3912	LAT – Latitudes for Start of Major Frame*	REAL*4	16
3913-3976	LON – Longitudes for Start of Major Frame*	REAL*4	16
3977-5256	TANEMS – Antenna Temperature (5 channels for avg, stdev, max, min per frame)	REAL*4	5x4x16
5257-5560	HKNEMS – Housekeeping Parameters for TANEMS above (38 items for avg. and stdev)	REAL*4	38x2
5561-5840	TBNEMS – Brightness Temperature (5 channels per earth-view frame)	REAL*4	5x14
5841-11440	PARAMS – Derived Geophysical Parameters (25x4 items per earth-view frame)	REAL*4	25x4x14
11441-11496	NFRC – NMC Data in PARAMS Table Flag: 1=yes, 0=no (1 flag per earth-view frame)	INT*4	14
11497-11560	FLAT – Fixed Latitude at Middle of Major Frame	REAL*4	16
11561-11624	FLON – Fixed Longitude at Middle of Major Frame	REAL*4	16

Table 3-2: IHNEMS – NEMS Submultiplex Data Assignments

Number	Function	Purpose	Nominal Accuracy
1	1777 (Base 8) Index	Sync	--
2	Instrument State	Data	--
3	Ch. 1 Signal Input Switch Temperature	Data	0.2°K
4	O_2 Signal Antenna Temperature #1	Data	0.2°K
5	Ch. 2 Mixer - Preamp Monitor -	Housekeeping	1%
6	O_2 Cal Radiator Temperature Fine	Data	0.1°K
7	Ch. 1 Mixer-Preamp Monitor +	Housekeeping	1%
8	Ch. 1 Cal Input Switch Temp	Data	0.2°K
9	O_2 Cal Radiator Temp Coarse	Data	0.2°K
10	Ch. 3 Mixer-Preamp Monitor +	Housekeeping	1%
11	O_2 Ref/Base Load Temperature Fine #1	Data	0.1°K
12	Ch. 1 Mixer-Preamp Monitor -	Housekeeping	1%
13	Ch. 2 Signal Input Switch Temperature	Data	0.2°K
14	O_2 Cal Load Temperature	Data	0.2°K
15	Ch. 3 Mixer-Preamp Monitor -	Housekeeping	1%
16	O_2 Ref/Base Load Temperature Fine #2	Data	0.1°K
17	Ch. 2 Mixer-Preamp Monitor +	Housekeeping	1%
18	Ch. 2 Cal Input Switch Temperature	Data	0.2°K
19	Ch. 4 Cal Input Switch Temperature	Data	0.2°K
20	Ch. 4 Mixer-Preamp Monitor +	Housekeeping	1%
21	Instrument Serial Number	Identification	--
22	H_2O Signal Antenna Temperature #1	Data	0.2°K
23	Ch. 3 Signal Input Switch Temperature	Data	0.2°K
24	Ch. 4 Signal Input Switch Temperature	Data	0.2°K
25	Ch. 4 Mixer-Preamp Monitor -	Housekeeping	1%
26	H_2O Cal Radiator Temperature Fine	Data	0.1°K
27	H_2O Cal Radiator Temperature Coarse	Data	0.2°K
28	Ch. 3 Cal Input Switch Temperature	Data	0.2°K
29	Ch. 5 Cal Input Switch Temperature	Data	0.2°K
30	Ch. 5 Mixer-Preamp Monitor +	Housekeeping	1%
31	H_2O Ref/Base Load Temperature Fine #1	Data	0.1°K
32	H_2O Cal Load Temperature	Data	0.2°K
33	P/S Module Temperature #1	Housekeeping	0.2°K
34	Ch. 5 Signal Input Switch Temperature	Data	0.2°K
35	Ch. 5 Mixer-Preamp Monitor -	Housekeeping	1%
36	H_2O Ref/Base Load Temperature Fine #2	Data	0.1°K
37	H_2O Ref/Base Load Temperature Coarse	Data	0.2°K
38	P/S Module Temperature #2	Housekeeping	0.2°K
39	O_2 Ref/Base Load Temperature Coarse	Data	0.2°K
40	Data System Voltage	Housekeeping	1%

Table 3-3: HDRMJF – Header for Major Frames

Number	Item	Number	Item
1	Read-Out Orbit Number	19	NEMS State =0, earth viewing =1, ambient-load viewing =2, cold=load viewing
2	Day in Year		
3	Hour in Day		
4	Starting Time of Major Frame (min x 100 + sec)		
5	Frame Number	20	NEMS Instrument Mode =0, normal =1, locked on antenna =2, locked on cold-load =3, locked on ambient-load
6	Altitude (km)		
7	Roll “counts” values		
8			
9			
10		21	Spare
11	Pitch “counts” values	22	=1, if day (ascending) =0, if night (descending) (found to be unreliable)
12			
13			
14		23	=1, if NEMS data unit on =0, if NEMS data unit off
15	Subsystems Status Bits (MSB=Bit 16, LSB=Bit 1) (see C.E. PIR-NTCC-1PH2-NE29)	24	=1, if NEMS channel 1 on =0, if NEMS channel 1 off
16	Subsystem Status Bits (Bit 28 thru Bit 17=LSB)	25	(same for channel 2)
		26	(same for channel 3)
17	Data Content of SET	27	(same for channel 4)
18	Sync Summary (Bits 1-2) =0, normally !=0, if Nimbus digital data unit malfunctions	28	(same for channel 5)
		29	Internal Processing Variable. (time space continuity code)
		30	=0, if no data =1, if good data =2, if bad data

Table 3-5: Contents of PARAMS Array

IX	PARAMS(IX,1,MF)	PARAMS (IX,2,MF)	PARAMS(IX,3,MF)	PARAMS(IX,4,MF)
1	Surface Reflectivity, ch.2	Blank	Surface Elevation (km)	Blank
2	Integrated Water Vapor (g/cm2)	Blank	NMC Forecast Integrated Water Vapor	NMC Analysis Integrated Water Vapor
3	Integrated Liquid Water (g/cm2)	Blank	Blank	Blank
4 5 6	1000 mb – 500 mb layer thickness (m) 500 mb – 250 mb layer thickness (m) 250 mb – 50 mb layer thickness (m)	Blank	NMC forecast of quantities in column 1 when available, otherwise set to -1.	NMC analysis values of quantities in column 1 when NFRC(MF) = 1.
7 8 9 10 11 12 13 14 15 16 17 18 19 20	Temperature (°K) at 1000 mb 850 700 500 400 300 250 200 150 100 70 50 30 10	Blank	NMC forecast of quantities in column 1 when available, otherwise set to -1.	NMC analysis values of quantities in column 1 when NFRC(MF) = 1.
 21 22	Equivalent Surface Brightness Temps e_1T_s, ch. 1 (°K) e_2T_s, ch. 2 (°K)	Blank	Surface Reflectivity $1-e_1$, ch. 1 $1-e_2$, ch. 2	 Blank Blank
23	Surface Type (Radiometric Determination) =1, if sea =2, if land	Blank	Blank	Climatic Type Code =1, if sea (0-30°) =3, if sea (30-60°) =5, if sea (60-90°) =10, if land tropical =12, if land temperate dry =14, if land temperate wet =16, if land cold
24	Surface Type (Geographic Determination) =1, if sea; =2, if land =3, if mixed	Blank	Blank	Blank
25	Blank	Blank	Blank	Blank

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.
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
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)
SouthBounding Coordinate	The southernmost latitude of the bounding rectangle(-90.0 to +90.0)
ElapsedMinTime	Duration in minutes of data collected.

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. In the PARAMS array, unused values are set to ‘FFFFFFFF’x which will translate into IEEE float -Inf. Unused LAT/LON Array values will be both set to 0.00000, and unused FLAT/FLON values will be both set to -100.000.

A sample FORTRAN program is included in the Appendix section which will read and print the the data contents. Additionally two FORTRAN functions are included to perform byte swapping, and another will convert 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/NEMSN5L2_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/Nimbus5_NEMS_Level2/NEMSN5L2.001/

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

"The Nimbus-5 User's Guide - Section 7 The Nimbus-E Microwave Spectrometer (NEMS) Experiment", NASA Goddard Space Flight Center, November 1972, Pages 141-157

"The NEMS Output Tape", 7 page document

7. Appendices

Acknowledgments

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

L2 Level-2 Data

NEMS: Nimbus-E Microwave Spectrometer

NASA: National Aeronautics and Space Administration

QA: Quality Assessment

UT: Universal Time

FORTRAN Code

```
C-----------------------------------------------------------------------
C ^NAME: READ_NEMS
C   This program will read both the Nimbus 5 NEMS Level 2 Output Data.
C
C   The files contain data records of size 11624 bytes. This program will
C   print the contents of every data record.
C
C ^MAJOR VARIABLES:
C     FNAME  - name of input file
C     BUFF   - buffer for data record
C     TEMP   - buffer for holding temporary 4-byte word
C     WORD   - integer 4-byte word
C     IBLKSZ - size of record block in bytes
C     IOS    - I/O status number
C
C ^NOTES:
C     Compile: gfortran -o READ_NEMS.EXE READ_NEMS.FOR
C
C ^ORGANIZATION: NASA/GSFC, Code 610.2
C
C ^AUTHOR:  James Johnson
C
C ^ADDRESS: james.johnson@nasa.gov
C
C ^CREATED: Dec. 18, 2020
C-----------------------------------------------------------------------

      CHARACTER          FNAME*256      ! Filename
      CHARACTER          BUFF(11624)    ! Buffer for data record block
      INTEGER*4          IBLKSZ         ! Size of records
      INTEGER*4          IWORD          ! 4-byte word
      CHARACTER          TEMP(4)        ! Buffer to hold 4-byte word
      EQUIVALENCE        (TEMP,IWORD)

C Get the name of the input data file to read
      WRITE (0, *), 'Enter the name of the input file:'
      READ (5,'(A)') FNAME
      PRINT '("FILE = ",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 N (record number) and IOFF (byte offset in file)
      N=0
      IOFF=0

C Loop through the file reading all records in file
   5  DO

C Read the first 4-byte word or record size header
   10   DO I=1,4
          READ (1, REC=IOFF+I, IOSTAT=IOS, ERR=90) TEMP(I)
        END DO
```

```
        IBLKSZ = IWORD
        IOFF=IOFF+(I-1)

C End-of-File (EOF) mark, exit loop
        IF (IBLKSZ .EQ. 0) EXIT

C Next read the block of data
   20   DO I=1,IBLKSZ
          READ (1, REC=IOFF+I, IOSTAT=IOS) BUFF(I)
          IF (IOS .NE. 0) THEN
            PRINT '("ERROR: BUFF ",I4,X,I4,", IOSTAT: ",I6)', N,I-1,IOS
            STOP
          END IF
        END DO
        IOFF=IOFF+(I-1)
        N=N+1

        PRINT '("==== REC ",I4," ===")', N
        CALL PRDREC(IBLKSZ,BUFF)

C Finally read the last 4-byte word (should match first record size)
   30   DO I=1,4
          READ (1, REC=IOFF+I, IOSTAT=IOS, ERR=90) TEMP(I)
        END DO
        IF (IBLKSZ .NE. IWORD) THEN
          PRINT '("WARNING: IBLKSZ ",I10," != ",I10)', IBLKSZ, IWORD
        END IF
        IOFF=IOFF+(I-1)

      END DO

C Close the input file
   90 CLOSE(1)
      STOP

   99 PRINT '("ERROR: OPEN FILE, IOSTAT: ",I6)', IOS

  100 STOP
      END
```

```
C-----------------------------------------------------------------------
C     This Subroutine will print the Data Records
C-----------------------------------------------------------------------
      SUBROUTINE PRDREC(IBLKSZ,BUFF)

      CHARACTER BUFF(11624)                          ! Buffer for record block
      INTEGER*2 ITNEMS(5,8,18),IHNEMS(40,18),        ! Short Int Arrays
     +          HDRMJF(30,16)
      INTEGER*4 NFRC(14)                             ! Long Int Array
      REAL*4    LAT(16),LON(16),TANEMS(5,4,16),      ! Float Arrays
     +          HKNEMS(38,2),TBNEMS(5,14),
     +          PARAMS(25,4,14),FLAT(16),FLON(16)
      INTEGER*2 I2SWAP                               ! Function swaps short ints
      INTEGER*4 I4SWAP                               ! Function swaps long ints
      REAL*4    R4IBM                                ! IBM float to IEEE float

C     Block/Segment Descriptors
      PRINT '("BLKDSC =",2(X,I8))',  I2SWAP(BUFF(1:2)),I2SWAP(BUFF(3:4))
      PRINT '("SEGDSC =",2(X,I8),/)',I2SWAP(BUFF(5:6)),I2SWAP(BUFF(7:8))

C     Antenna Temperature Counts
      N=9
      DO MF=1,18
        DO IM=1,8
          DO IC=1,5
            ITNEMS(IC,IM,MF) = I2SWAP(BUFF(N:N+1))
            N = N+2
          END DO
        END DO
      END DO
      PRINT '("ITNEMS = ",18(/,8(5(X,I6),/)))', ITNEMS

C     Submultiplex Housekeeping/Data
      DO MF=1,18
        DO ISM=1,40
          IHNEMS(ISM,MF) = I2SWAP(BUFF(N:N+1))
          N = N+2
        END DO
      END DO
      PRINT '("IHNEMS = ",/,18(4(10(X,I6),/)))', IHNEMS

C     Header for each Major Frame
      DO MF=1,16
        DO I=1,30
          HDRMJF(I,MF) = I2SWAP(BUFF(N:N+1))
          N = N+2
        END DO
      END DO
      PRINT '("HDRMJF = ",/,16(3(10(X,I6),/)))', HDRMJF

C     Latitude for Start of Major Frame (missing set to 0.00000)
      DO MF=1,16
        LAT(MF) = R4IBM(I4SWAP(BUFF(N:N+1)))
        N = N+4
      END DO
      PRINT '("LAT    = ",/,2(6(X,G12.6),/),4(X,G12.6),/)', LAT
```

```
C     Longitude for Start of Major Frame (missing set to 0.00000)
      DO MF=1,16
        LON(MF) = R4IBM(I4SWAP(BUFF(N:N+1)))
        N = N+4
      END DO
      PRINT '("LON    = ",/,2(6(X,G12.6),/),4(X,G12.6),/)', LON

C     Antenna Temperatures
      DO MF=1,16
        DO I=1,4
          DO IC=1,5
            TANEMS(IC,I,MF) = R4IBM(I4SWAP(BUFF(N:N+1)))
            N = N+4
          END DO
        END DO
      END DO
      PRINT '("TANEMS = ",16(/,4(5(X,G12.6),/)))', TANEMS

C     Housekeeping Calibration Cycle
      DO J=1,2
        DO I=1,38
          HKNEMS(I,J) = R4IBM(I4SWAP(BUFF(N:N+1)))
          N = N+4
        END DO
      END DO
      PRINT '("HKNEMS = ",/,(6(6(X,G12.6),/),2(X,G12.6),/))', HKNEMS

C     Brightness Temperatures
      DO MF=1,14
        DO IC=1,5
          TBNEMS(IC,MF) = R4IBM(I4SWAP(BUFF(N:N+1)))
          N = N+4
        END DO
      END DO
      PRINT '("TBNEMS = ",/,14(5(X,G12.6),/))', TBNEMS

C     Parameters (unused set to 'FFFFFFFF'X translates to IEEE -Inf)
      DO MF=1,14
        DO IY=1,4
          DO IX=1,25
            PARAMS(IX,IY,MF) = R4IBM(I4SWAP(BUFF(N:N+1)))
            N = N+4
          END DO
        END DO
      END DO
      PRINT '("PARAMS = ",14(/,4(4(6(X,G12.6),/),X,G12.6,/)))', PARAMS

C     NMC Flags
      DO MF=1,14
        NFRC(MF) = I4SWAP(BUFF(N:N+1))
        N = N+4
      END DO
      PRINT '("NFRC   = ",/,11(X,I6),/,3(X,I6),/)', NFRC
```

```
C     Fixed Latitude for Middle of Major Frame (missing set to -100.0)
      DO MF=1,16
        FLAT(MF) = R4IBM(I4SWAP(BUFF(N:N+1)))
        N = N+4
      END DO
      PRINT '("FLAT   = ",/,2(6(X,G12.6),/),4(X,G12.6),/)', FLAT

C     Fixed Longitude for Middle of Major Frame (missing set to -100.0)
      DO MF=1,16
        FLON(MF) = R4IBM(I4SWAP(BUFF(N:N+1)))
        N = N+4
      END DO
      PRINT '("FLON   = ",/,2(6(X,G12.6),/),4(X,G12.6),/)', FLON

      RETURN
      END

C-----------------------------------------------------------------------
C ^FUNCTION: I2SWAP
C
C     This function will swap the bytes of a 2-byte word
C-----------------------------------------------------------------------
      INTEGER*2 FUNCTION I2SWAP(BUFF)

      CHARACTER          BUFF(2)        ! Input data buffer
      CHARACTER          TEMP(2)        ! Output swapped buffer
      INTEGER*2          I2BUFF
      EQUIVALENCE        (TEMP, I2BUFF)

      TEMP(1) = BUFF(2)
      TEMP(2) = BUFF(1)
      I2SWAP = I2BUFF

      RETURN
      END

C-----------------------------------------------------------------------
C ^FUNCTION: I4SWAP
C
C     This function will swap the bytes of a 4-byte word
C-----------------------------------------------------------------------
      INTEGER*4 FUNCTION I4SWAP(BUFF)

      CHARACTER          BUFF(4)        ! Input data buffer
      CHARACTER          TEMP(4)        ! Output swapped buffer
      INTEGER*4          I4BUFF
      EQUIVALENCE        (TEMP, I4BUFF)

      TEMP(1) = BUFF(4)
      TEMP(2) = BUFF(3)
      TEMP(3) = BUFF(2)
      TEMP(4) = BUFF(1)
      I4SWAP = I4BUFF

      RETURN
      END
```

```
C-----------------------------------------------------------------------
C ^FUNCTION: R4IBM
C
C     This function will convert an input word to an IBM float
C-----------------------------------------------------------------------
      REAL*4 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
```