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

README Document for the Nimbus-4 Satellite Infrared Spectrometer (SIRS) Level 1 Radiance Data

SIRSN4L1

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Revision History

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1. Introduction

This document provides basic information on using the Nimbus-4 Satellite Infrared Spectrometer (SIRS) Level-1 Radiance Data product.

1.1 Data Product Description

The Nimbus-4 Satellite Infrared Spectrometer (SIRS) Level-1 Radiance Data product contains radiances that were measured at fourteen wavelength bands from 11 to 36 microns. Each file contains up to one days worth of data (~14 orbits per day). The SIRS instrument could scan up to 37.8 degrees each side of nadir along the orbital track to provide full global spatial coverage (-90 to +90 degrees). The data are available for the days from 8 April 1970 to 8 April 1971. The principal investigators for the SIRS experiment was David Wark from the NOAA National Environmental Satellite, Data and Information Service.

This product was previously available from the NASA National Space Science Data Center (NSSDC) under the name Satellite Infrared Spectrometer Radiance with the identifier ESAD-00130 (old id 70-025A-04A).

1.1.1 The Satellite Infrared Spectrometer

The objective of the Nimbus-4 Satellite Infrared Spectrometer (SIRS) experiment was designed to determine the vertical temperature and water vapor profiles of the atmosphere by using a Fastie-Ebert fixed-grating spectrometer. The SIRS instrument on Nimbus-4 was a follow-on to the instrument flown previously on Nimbus-3, but with the added capabilities of spatial scanning and determination of tropospheric water vapor content. One of the 14 detector channels is in the atmospheric window (899 cm^{-1}), seven channels in the carbon dioxide band (668.7 to 750 cm^{-1}), and six channels in the water vapor band (280 to 531.5 cm^{-1}).

The instrument was activated on orbit 3 shortly after launch on April 8, 1970. Problems in the SIRS instrument calibration after April 1971, in addition to spacecraft yaw problems, significantly reduced the number of useful soundings obtained. The archival data were produced through April 8, 1971.

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 SIRS data were generated from the spacecraft telemetry, attitude and orbital data. The data were originally processed on IBM 360 computers using 24-bit words, and copied to 6250 tapes for archival. Further information on the SIRS instrument and data processing can be found in the Nimbus-4 Users' Guide Section 5.

1.3 Data Disclaimer

The data should be used with care and one should first read the Nimbus-4 User’s Guide, Section 5 describing the SIRS experiment. Users should also review the Nimbus-4 Data Catalog section on SIRS which includes information on data usage and description of the file format. Users should cite this data product in their research.

2. Data Organization

The Nimbus-4 Satellite Infrared Spectrometer (SIRS) data span the time period from April 8, 1970 to April 8, 1971. Each file typically contains one full days worth of data (~14 orbits per day).

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 (Nimbus4)
o) Instrument = name of the instrument and product (SIRS)
o) Level = process level (L1)
o) Date = Data start date and time in UTC in format <YYYY>m<MMDD>t<hhmmss> where

1. YYYY = 4 digit year (1978 – 1979)
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 (00-59)
6. ss = 2 digit second (00-59)

o TapeNumber = 3 digit number of tape (preceded by 'DR' - primary)
o Suffix = the file format (always TAP, indicating tape binary data)

```
File name example: Nimbus4-SIRS_L1_1970m0411t002447_DR847.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 6250 tapes using a blocked FORTRAN format. The first file on the tape is the tape header file with two records containing text encoded information about the tape. This is followed by up to five daily data files. Each daily file on the tape contains a set of records with a FORTRAN record size word, the data record, and a FORTRAN record trailing size word. Record blocks are 5100 bytes, which contain 85 logical data records each consisting of fifteen 24-bit words. There may be up to 12,000 data records in a full daily file. At the end of the daily file there is an End-of-File word (the last file on the tape will end with a double End-of-File word). Each data record in a file represents one SIRS measurement with IR radiances for each of the 14 wavelength bands from 11 to 36 microns. Each data file typically contains one full days worth of data (about 14 orbits per day). For the contents and layout of the data, see section 3.1

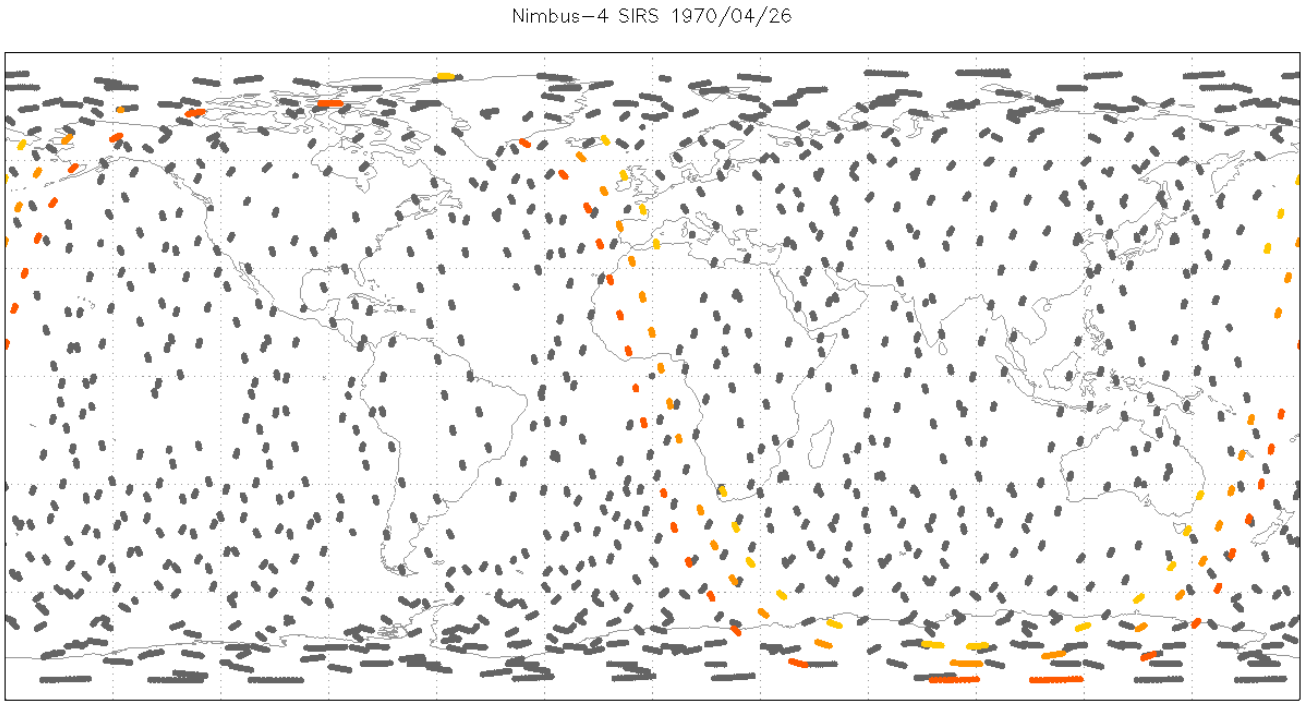
During data recovery a total of 338 data files were retrieved from 3 primary tapes (designated by a DR prefix), there were no backup tapes in the recovery. Caution should be taken as some data

records contain corrupted time information (e.g. year is not set to either 70 or 71, and other problems). All of the files are unique, although two are short, Nimbus4-SIRS_L1_1970m0628t224253_DR847.TAP and Nimbus4-SIRS_L1_1970m0706t235549_DR847.TAP. These two files fill the time gap between adjacent data files. All Nimbus-4 SIRS files are archived at the GES DISC.

2.3 Key Science Data Fields

The primary science data fields in this data product are the SIRS calibrated radiances for each of the fourteen IR channels.

Figure 1: Typical Nimbus-4 SIRS Level 1 data file showing data coverage in dark gray, with one orbit shown in orange (dark is scan left of nadir, medium is scan at nadir, and light is scan to right of nadir).



3. Data Contents

The granularity of this data product is one day (with approx. 14 orbits).

3.1 Data Records

The Nimbus-4 User's Guide does not describe the layout of the file format. Refer instead to the description of the tape format in section 1.5.3, vol 1, "The Nimbus 4 Data Catalog".

The original tape files each included a tape header file. These were then followed by a set of up to 15 orbit data files, which would include about 260 data records consisting of the up and down limb scan profiles. As part of the recovery, the GES DISC has extracted and archived the daily data files from the tape. The original data were written on IBM machines using 24-bit words. During tape data recovery these words were saved as three 8-bit bytes (some words consist of two 12-bit half words). Each data record consists of fifteen 24-bit words (see Table 3-1 below), there are typically 85 data records per record block. Each record block starts and ends with a four byte 32-bit integer word giving the record size in bytes.

Table 3-1: Data Record (fifteen 24-bit words)

Word	Field Name	Units	Type	Comments
1	Calibration code and quality flags		1 word	* below
2	Day Number		1 word	
3	Month		1 word	
4	Year (2 digit)		1 word	
5	Time (seconds since start of day in GMT)		1 word	
6	Principal Point Latitude		1 word	
7	Principal Point Longitude		1 word	
8	Zenith Angle		1 word	
9 – 15	Radiance, Channels 1 – 14		7 ½ words	** below

* bits 0 – 13 hold the quality flags (channel 14 is bit 0, channel 13 is bit 1, etc.)
bits 20 – 23 hold the calibration codes

** Radiance channel 1 is word 9 bits 23 – 12, channel 2 is word 9 bits 11 – 0
Radiance channel 3 is word 10 bits 23 – 12, etc.

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 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.

A sample FORTRAN program is included in the Appendix section which will read in the data records. Additionally a FORTRAN function is included to perform byte swapping.

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/SIRSN4L1_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_SIRS_Level1/SIRSN4L1.001/

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
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6.2 References

"The Nimbus-4 User's Guide - Section 5: The Satellite Infrared Spectrometer (SIRS) Experiment", NASA Goddard Space Flight Center, March 1970, Pages 101-133

"The Nimbus 4 Data Catalog, Volume 1: Section 1.5 The Satellite Infrared Spectrometer (SIRS) Experiment", NASA Goddard Space Flight Center, August 1970, Pages 1-4, 1-13 and 1-14.

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

L1: Level-1 Data

NASA: National Aeronautics and Space Administration

QA: Quality Assessment

SIRS: Satellite Infrared Spectrometer

UT: Universal Time

FORTRAN Code

```
C-----------------------------------------------------------------------
C ^NAME: READ_SIRSN4
C   This program will read a Nimbus 4 SIRS Radiance Archival Tape (RAT)
C   Level-1 data file.
C
C   The Nimbus 4 SIRS files contain a series of data records. Each of the
C   data records contain the radiances from the 14 SIRS channels, as well as
C   time, geolocation and quality flags. This program will print the contents
C   of each 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_SIRSN4.EXE READ_SIRSN4.FOR
C
C ^ORGANIZATION: NASA/GSFC, Code 610.2
C
C ^AUTHOR:  James Johnson
C
C ^ADDRESS: james.johnson@nasa.gov
C
C ^CREATED: June 6, 2019
C-----------------------------------------------------------------------

      CHARACTER          FNAME*1024     ! Filename
      CHARACTER          BUFF(21484)    ! 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
   10 DO
```

```
C Read the first 4-byte word or record size header
        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, continue
        IF (IBLKSZ .EQ. 0) GOTO 10

C Next read the block of data
        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
            IBLKSZ = I-1
            GOTO 20
          ENDIF
        END DO
        IOFF=IOFF+(I-1)
        N=N+1

C Split data records from record block
        CALL PRDREC(IBLKSZ,BUFF)

C Finally read the last 4-byte word (should match first record size)
   20   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
        ENDIF
        IOFF=IOFF+(I-1)

      END DO

C Close the input file
   90 CLOSE(1)
      GOTO 100

   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(21484)                     ! Buffer for record block
      CHARACTER     DREC(15*4)                      ! Buffer for data records
      CHARACTER     TEMP(4)                         ! Temp buffer for word
      INTEGER*4     IWORD                           ! Word value
      INTEGER*1     IQFLAG(14)                      ! 14 quality flags
      INTEGER*1     ICALCD                          ! Calibration code
      INTEGER*2     IRAD(14)                        ! Radiance values
      EQUIVALENCE   (TEMP,IWORD)

      NRECS = IBLKSZ/(15*4)
      IF (NRECS.GT.85) THEN
        NRECS=85                                    ! Rest is garbage
      ENDIF

      DO I = 1,NRECS
        DREC = BUFF((I-1)*15*4+1:(I*15)*4)
        DO J = 1,15
          TEMP = DREC((J-1)*4+1:J*4+1)
          CALL I24I32(IWORD)
          IF      (J.EQ.1) THEN
            ICALCD = ISHFT(IWORD,-20)               ! left 4 bits calib code
            DO L = 14,1,-1
              IQFLAG(L) = IAND(ISHFT(IWORD, L-14),1) ! right 14 bits qual flags
            END DO
            PRINT '("CQFLAG",X,I3,",",14(X,I1))',ICALCD,IQFLAG
          ELSE IF (J.EQ.2) THEN
            PRINT '("DAY   ",X,I8)', IWORD
          ELSE IF (J.EQ.3) THEN
            PRINT '("MONTH ",X,I8)', IWORD
          ELSE IF (J.EQ.4) THEN
            PRINT '("YEAR  ",X,I8)', IWORD
          ELSE IF (J.EQ.5) THEN
            PRINT '("TIME  ",X,I8)', IWORD
          ELSE IF (J.EQ.6) THEN
            IF (ISHFT(IWORD,-23).EQ.1) THEN
              IWORD = IWORD - 2**24                 ! negative value
            ENDIF
            PRINT '("LAT   ",X,F8.2)', IWORD/100.
          ELSE IF (J.EQ.7) THEN
            IF (ISHFT(IWORD,-23).EQ.1) THEN
              IWORD = IWORD - 2**24                 ! negative value
            ENDIF
            PRINT '("LON   ",X,F8.2)', IWORD/100.
          ELSE IF (J.EQ.8) THEN
            IF (ISHFT(IWORD,-23).EQ.1) THEN
              IWORD = IWORD - 2**24                 ! negative value
            ENDIF
            PRINT '("ZA    ",X,F8.2)', IWORD/100.
```

```
          ELSE
            IRAD(2*(J-9)+1) = ISHFT(IWORD,-12)
            IRAD(2*(J-9)+2) = IAND(IWORD,'000FFF'Z)
            IF (J.EQ.15) THEN
              PRINT '("RAD  ",14(X,I4))', IRAD
            END IF
          END IF
        END DO
        PRINT '("---------------")'
      END DO

      RETURN
      END

C-----------------------------------------------------------------------
C     This Subroutine will convert 24-bit word to 32-bits
C-----------------------------------------------------------------------
      SUBROUTINE I24I32(IWORD)

      INTEGER*4     I4TEMP                      ! 15 word data record
      CHARACTER     TEMP(4)                     ! Temp buffer for data record
      EQUIVALENCE   (TEMP,I4TEMP)

      I4TEMP = IWORD
      IW = 0
      DO K = 1,4
        IW = ISHFT(IW, 6)                       ! Shift left by 6 bits
        IW = IOR(IW,IAND(ICHAR(TEMP(K)),Z'3F')) ! Remove 2 most signif bits
      END DO
      IWORD = IW

      RETURN
      END
```