



README Document for

Nimbus 2

Medium Resolution Infrared Radiometer

(MRIR) Level 2 Data

MRIRN2L2

MRIRN2IM

README document for Nimbus II MRIR

Aug. 11, 2011

Version 1.1

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Revision date	Changes	Author
04/22/2009	Initial version	Jean-Jacques Bedet
08/11/2011	Added image file info, Reverb URL	James Johnson

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## 1 Introduction

### 1.1 Brief Background

This document applies to the Nimbus II Medium Resolution Infrared Radiometer (MRIR) Level-2 data.

The Nimbus II Medium Resolution Infrared Radiometer (MRIR) was designed to measure electromagnetic radiation emitted and reflected from the earth and its atmosphere at 5 wavelengths.

The five wavelengths regions are as follows:

6.7 to 6.9 microns- This channel covers the 6.7 micron water vapor absorption band. Its purpose is to provide information on water vapor distribution in the upper troposphere and, in conjunction with the other channels to provide data concerning relative humidities at these altitudes

10 to 11 microns - microns- This channel measures surface or near surface temperatures over clear portions of the atmosphere. It also provides cloud cover and cloud height information (day and night).

14 to 16 microns – This channel, centered about the strong absorption band of CO<sub>2</sub> at 15 microns, measures radiation which emanates primarily from the stratosphere.

5 to 30 microns – This channel measures the emitted long wavelength infrared energy and, in conjunction with the reflected solar radiation channel furnishes data on the heat budget of the planet.

0.2 to 4.0 microns – This channel covers more than 99% of the solar spectrum and yields information on the intensity of the reflected solar energy from the earth and its atmosphere.

The Nimbus II was launched on may 15, 1966 on a Thrust Augmented Thor (TAT)/ Agena B vehicle. Three instruments were on board of the spacecraft.

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- An Advanced Vidicon Camera System (AVCS) provided clouds in the earth atmosphere and, in clear areas, terrestrial features on the earth's surface (only during day-time).
- A Medium Resolution Infrared Radiometer (MRIR) measured the electromagnetic radiation emitted and reflected from the earth and the atmosphere in five selected wavelengths (6.4-6.9, 10-11, 14-16, 5-30, 0.2-4.0 microns)
- A High Resolution Infrared Radiometer (HRIR) was available to provide earth cloud cover (nigh-time) and to measure the temperatures of cloud tops and terrain features.

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

- near-circular orbit with apogee of 1179 km
- perigee height of 1095 km
- inclination of 100.311 degrees
- nodal period of 108.17 minutes
- near sun-synchronous

The Nimbus II MRIR data are available from 15 May 1966 (Day of year 135) through 28 July 1966 (Day of year 209).

### 1.2 Brief Background on Instruments

The radiant energy from the earth is collected by a mirror inclined to 45 degrees to the axis of rotation (scans perpendicular to flight path). The incident flux is focused onto a thermistor bolometer detector through appropriate filtering which limits the radiation to the desired wavelengths. A portion of a scan yields in-flight data calibration. The energy is modulated by a mechanical chopper to produce an AC signal from the detector. The signals are sampled 33.33 times per second.

### 1.3 Brief Background on Algorithms

The Nimbus II MRIR data was generated from the spacecraft telemetry, attitude data, orbital data. Digitized radiation data, and the Nimbus radiometer calibration package. The data are were created on IBM computers using a 36 bit architecture. Further information can be found on the Nimbus II Users' guide.

## 2 Data Organization

### 2.1 Background

### 2.2 Granularity

The Nimbus II MRIR were originally archived on 7-track tapes and then restored to 9-track tapes. The data in both 7-track and 9-track tapes were stored in 36-bit IBM binary format. A Canadian company (JBI) was contracted to restore to disks all 8 Nimbus II MRIR 9-track tapes. The content of each tape was written using a proprietary format (TAP) that allowed “bad” records to be flagged. Since tapes contain many files, the content of each file on a tape was retrieved and stored in a separate disk file using the same TAP format.

The Nimbus II MRIR 9-track tapes were archived at the National Space Science Data Center (NSSDC). The tape recovery process involved using specially developed tape drives, bit detection and processing techniques to read the 9-track tapes and store the recovered data in TAP(tape emulation format).

Because a tape may contain multiple files, and in some cases multiple orbits, each tape was read and the content of each file stored on a separate file on disk. The overall TAP format and data on tape was preserved. The TAP files were archived and ingested at the Goddard Earth Sciences Data and Information Services Center (GES DISC) and are available for users to download.

### 2.3 File Naming Convention

The Nimbus II MRIR level 2 data are named according to the following convention:

`<satellite>-<instrument>-<YYYYMMDD>_<hh-mm-ss>_<orbit>_<version>.TAP` where:

*satellite* is always Nimbus2

*instrument* is always HRIR

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*YYYYMMDD* is the starting date when the data was collected from the satellite and

*YYYY*: starting 4 digit calendar year (e.g. 1966)

*MM*: starting 2 digit month (e.g. 02 for February)

*DD*: starting 2 digit day of the year (e.g. 04 for day four)

*hh-mm-ss* is the starting time when the data was collected from the satellite and

*hh* : starting 2 digit hour (0-23) (e.g. 02 for hour 2)

*mm*: starting 2 digit minute (0-59) (e.g., 09 for 9 minutes)

*ss*: starting 2 digit seconds (0-59) , (e.g. 11 for 11 seconds)

*orbit* is the orbit number

*version* is a 3 digit number (e.g. 001)

2.4 File Format (TAP)

2.4.1 TAP bytes

The first 8 bits retrieved from a 9-track restored tape was stored in a byte as described in the following Figure 1 . The tape parity bit (8<sup>th</sup> bit) was not kept during the restoration process. Bit 0-7 from tape were stored as bit 0-7 on disk.

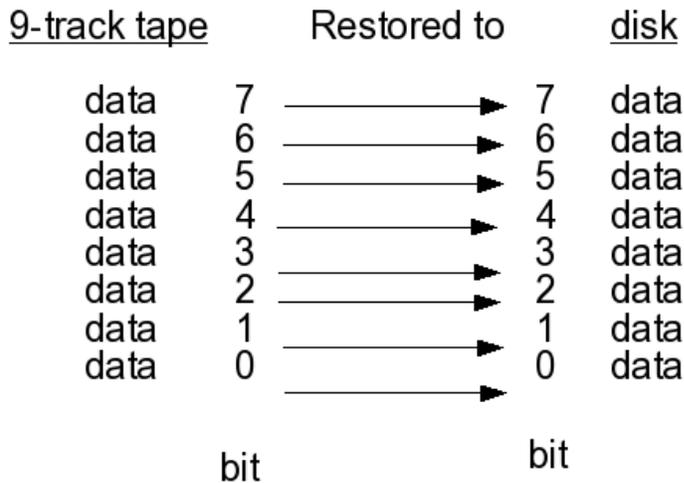


Figure 1: bit restoration from tape to disk

## 2.4.2 TAP headers

TAP headers are interleaved between the Nimbus II MRIR data records to indicate the length of the following and preceding data records. A TAP header is a 4 byte record which follows the following convention.

- A number greater than zero indicates the length of a record
- A negative number indicates that a record has bytes that could not be restored from tapes and filled with zeros. The length of a record is obtained by taking the absolute value.
- a zero indicates the start of a file
- Two consecutive TAP headers with zero values are used to specify the end of a file.
- A data record is preceded by a header and followed by a header listing the length of the data record

An example of a C program to retrieve the length of a TAP header is illustrated in Appendix 7.1

## 2.4.3 Nimbus II MRIR Word

The basic unit of the Nimbus II data is a word which is a 36-bit IBM binary word. This means that in order to extract a 36-bit word from the restored files, 4.5 bytes (8-bits) must be read. With half 36 bit words, 2.25 bytes must be read. An example of how to extract a 36 bit word or ½ 36 bit word is illustrated in Appendix 7.2

To preserve space while maintaining a good resolution, data were originally stored using a scaling technique. The idea was to multiply a number by a factor before storing the value to tapes. Nimbus II data can be converted back to the initial value by dividing the stored value on tape (or TAP files) by  $2^{(35-B)}$ , where B is the scaling factor listed on the Nimbus II Data record format Table 1, Table 2, Table 3, and Table 4.

A word of 36 bits with a scaling factor of B is converted by using the relation:

$$\text{value} = (\text{integer value of 36 bits}) / (2^{(35-B)})$$

When a word is divided in two ½ Word (WordD, and WordA), the actual values are converted by using the relation:

A wordD of 18bits with a scaling factor of B is converted in real by using the relation:

$$\text{value} = (\text{integer value of 18 bits}) / (2^{(17-B)})$$

A wordA of 18bits with a scaling factor of B is converted in real by using the relation:

$$\text{value} = (\text{integer value of 18 bits}) / (2^{(35-B)})$$

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The scaling factor is mentioned and used in tables describing the Nimbus II MRIR records.

## 2.5 Data Structure Inside a File

Two TAP 4 byte headers are stored before and after each Nimbus II MRIR records. The first Nimbus II MRIR record is an orbit data document record (68 bytes) followed by multiple data records. A Nimbus II data record is composed of a Data record documentation followed by several swath data records. The length of a data record (L) in words can be computed using the relation.

$$L = (\text{swaths per records}) * (\text{words per swath}) + (\text{number of nadir angles}) + 7$$

The overall structure of the Nimbus II files is depicted in Figure 2

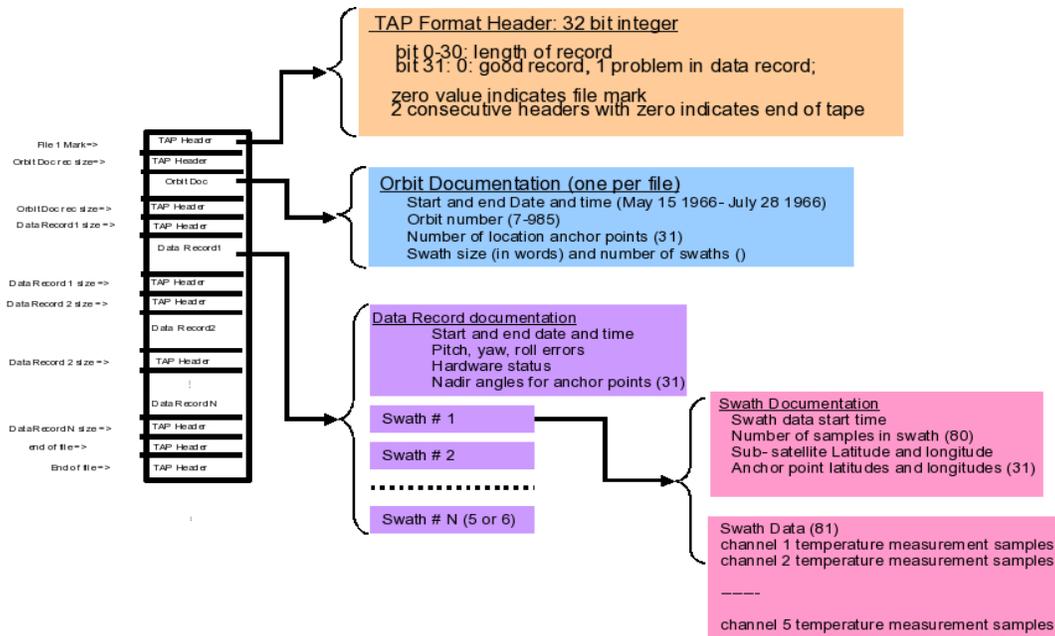


Figure 2: Nimbus II MRIR file structure

## 2.6 Key metadata fields

These are most likely to be used by users:

### Temporal

- start Date / Time
- end Date/ Time

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## Geolocation

- latitude
- longitude

## 3 Data Contents

Described below are all the parameters associated with the Nimbus II MRIR files.

Table 2 describes in details all the parameters associated with an orbit. There is one orbit documentation record per file.

Table 3 describes in details all fields in a record documentation. There is one data record documentation per data record

Table 4 describes in details all fields in a swath data record. There are multiple swath data records in a single data record.

## 4 Data Services

Nimbus II MRIR products can be searched and ordered by using Reverb, ECHO's next generation metadata and services discovery tool at:

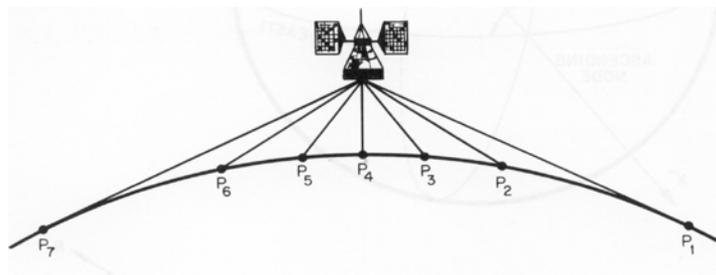
<http://reverb.echo.nasa.gov/>

## 5 Data Interpretation and Screening

### 5.1 Geolocation

The MRIR radiometer scans the earth in a clockwise direction from right to left. Each earth scan is defined by a family of mirror nadir angles. For each mirror angle, the latitude and longitude of the corresponding point on the earth's surface is recorded. The position of individual samples between two anchor points is determined by interpolation.

The latitude and longitude of the corresponding point on the earth's surface are used as references in computation of positions for each sample. There is still no information available describing how many anchor points were used for a swath. This issue is still being investigated.



**Figure 3: Nimbus II anchor points**

## 6 More Information

### 6.1 Web Resources

#### **NASA/GSFC**

Nimbus Documentation:

[ftp://acdisc.gsfc.nasa.gov/data/s4pa/Nimbus2\\_MRIR\\_Level2/MRIRN2L2.001/doc/](ftp://acdisc.gsfc.nasa.gov/data/s4pa/Nimbus2_MRIR_Level2/MRIRN2L2.001/doc/)

### 6.2 Point of Contact

URL: <http://disc.gsfc.nasa.gov/>

Name: GES DISC Help desk support group

email: [help-disc@listserv.gsfc.nasa.gov](mailto:help-disc@listserv.gsfc.nasa.gov)

phone: 301-614-5224

fax: 301-614-5268

Address: Goddard Earth Sciences Data and Information Services Center

Code 610.2

NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

### 6.3 Nimbus II references

- Nimbus II users' guide, July 1966
- The Nimbus II advanced vidicon camera system data ; world montage catalog , 20 May through 31 August 1966
- The medium II medium resolution infrared pictorial data catalog volume 1 15 May through 21, June 1966
- The radiation balance of the earth-atmosphere system over both polar regions obtained from radiation measurements of th nimbus II meteorological satellite, September 1967
- Nimbus II flight evaluation and engineering report, Launch through orbit 5275 , February 1969

## 7 Appendices

### 7.1 Example on how to extract the record length listed in a TAP using C

```

/* read a TAP header and return the value of the next record */
int Read_TAP_Header (ifd) /* read TAP header */

int ifd;

/* This function reads a TAP header ( 4 bytes) and return the size in bytes
of the next record to read
input
    ifd: file reference
output
    reclen: size of the next record in bytes
*/

{
BYTE bytebuf[200];
int j, size, value,reclen,signbit,mask;
char tap_mess[100],reclen_str[20];

    size = read( ifd, bytebuf, 4); /* read 4 bytes header */

    mask = 1 ;
    signbit = (bytebuf[0] >> 7) & mask; /* get sign bit */
    value = 0;

    /* concatenate 4 bytes into an integer */
    for (j=0; j<=3; j++)
    {
        value = value << 8;
        value = value | bytebuf[3-j];
    }

    reclen = value;
    return reclen;
}

```

### 7.2 Example on how to extract a word (36 bits from) from a TAP file using C

From main read reclen bytes of data into bytebuf.

Where ifd is an integer and bybuf is an array of unisgned char

```

size = read( ifd, bytebuf, reclen) ;

```

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read first ½ word

```
val1 = (float) GetWord2( &bytebuf[0],2.25,1,offset);  
offset = offset + 2.25;
```

read 2<sup>nd</sup> ½ word

```
val2 = (float) GetWord2( &bytebuf[0],2.25,1,offset);  
offset = offset + 2.25;
```

long long GetWord2 (initval,len,pos,offset)

```
BYTE initval[];  
float len;  
int pos;  
float offset;
```

/\* this function calculates the values of a word of size len bytes

input

initval array containing the bytes

len number of bytes (e.g. 4.5 for 36 bits, 2.25 for words 18 bits)

pos word position of length len i n the array initval >= 1

offset # of bytes offset from the beginning of initval ( e.g. 2.25 for half word )

output

value integer containing the computed value of the word  
scaling factor is not applied to the word

\*/

{

```
int j,start_byte,end_byte,start_shift,end_shift,nloop;
```

```
BYTE byteclean,signbit;
```

```
long long value,signval;
```

```
float start_word,end_word;
```

```
value = 0;
```

```
start_byte = (int) floor( (double) (len*(pos-1) + offset) );
```

```
end_byte = (int) (start_byte + len) ;
```

```
start_word = (float) (len*(pos-1)+offset) ;
```

```
end_word = (float) (len*pos+offset);
```

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```
start_shift = (int) ((start_word -start_byte)*8);
end_shift  = (int) ((end_word - floor( (double) end_word))*8);
if (end_shift > 0 ) { end_shift = 8 - end_shift;}

signbit=0;
value = value << 8;
byteclean = initval[start_byte];
byteclean = byteclean << start_shift;
signbit = byteclean ;
signbit = signbit >> 7; /* get sign bit */
byteclean = byteclean << 1;
byteclean = byteclean >> start_shift+1;
value = value | byteclean;

for (j=start_byte+1; j< end_byte; j++) {
    value = value << 8;
    value = value | initval[j];
}

value = value << 8;
value = value | initval[end_byte];
value = value >> end_shift;

signal = 1;
if (signbit == 1 ) { signal = -1;}
return signal*value;
}
```

### 7.3 Description of all metadata fields

Following is a list of the XML metadata fields and a brief description for the Nimbus II MRIR data.

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<b>Field</b>	<b>Description</b>	<b>value</b>
Shortname	Short product name	MRIRN2L2
Longname	Long product name	Nimbus Meteorological Radiation Tape - MRIR (NMRT-MRIR)
VersionID	Product version ID. This is related to the ingested not the version of the processed data.	Example: 001
GranuleID	Granule ID. Granule and file are the same.	Example: Nimbus2-MRIR-19660530_14-16-38_1043_001.TAP
Format	Proprietary File Format (see section on TAP for a full description)	TAP
TotalSize	Total Size of the granules in Bytes	Example: 4855962
Insert Time	Date and time when the granule was inserted into the DISC. The date is YYYY-MM-DD and the time is in hh-mm-ss format	Example: 2009-05-30 17:20:44
TimeCoverage BeginDateTime	Beginning Date and time when the data was collected from the satellite. The date is YYYY-MM-DD and the time is in hh-mm-ss format	Example: 1966-05-30 14:16:38
TimeCoverage EndDateTime	End Date and time when the data was collected from the satellite. The date is YYYY-MM-DD and the time is in hh-mm-ss format	Example: 1966-05-30 15:11:08
File name	Name of the file . In this case granuleID and File name are the same. See section on File naming convention for a full description.	Nimbus2-MRIR-19660530_14-16-38_1043_001.TAP
File Checksum Type	Type of Checksum	CRC32
File Checksum Value	Value of the checksum using cksum	Example: 3378917185

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<b>Field</b>	<b>Description</b>	<b>value</b>
File Size in Bytes	Size of the file in Bytes	Example: 4855962
Platform instrument	Name of the instrument	MRIR
Platform Sensor	Name of the sensor	MRIR
Gpolygon latitude	Latitudes of the polygons that represent the satellite coverage. Rectangles have been selected in this case. Each point of a rectangle is identified by its latitude and longitude	Example: -80.000000 -90.000000 -90.000000 -80.000000
Gpolygon longitude	Longitudes of the polygons that represent the satellite coverage. Rectangles have been selected in this case. Each point of a rectangle is identified by its latitude and longitude	Example: 180.000000 180.000000 -180.000000 -180.000000
Orbit	Nimbus II satellite orbit number. There is one orbit per file. A given orbit may have several files (partial orbits or data collected from different stations)	Example: 1043
Average Elevation	Average elevation in km of the nimbus II satellite during an orbit	Example: 1140.915
Station Code	DAF Station identification code	Example: 2
Elapsed_Min_Time	Duration in minutes of data collected during an orbit	Example: 25

**Table 1: Nimbus II MRIR Metadata field Description**

#### 7.4 Description of orbit documentation records

This record is unique for each file and provides information on the starting and end Date/time for a file, size and number of swaths, orbit number, and the number of anchor points used to identify the geo-location of the data.

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Table 1 Describes in details the fields, units, and scaling factors.

Word No.	Quantity	Units	Scaling	Remarks
1	Nimbus Day	-----	B=35	Start day of the year (1966) for this file (orbit)
2	Hour	hh	B=35	Start hour for this file(orbit)
3	Minute	mm	B=35	Start minute for this file(orbit)
4	Second	ss	B=35	Start seconds for this file(orbit)
5	Nimbus Day	-----	B=35	End day of the year (1966) for this orbit
6	Hour	hh	B=35	End hour for this orbit
7	Minute	mm	B=35	End minute for this orbit
8	Second	ss	B=35	End seconds for this orbit
9	Mirror Rotation	Deg/Sec	B=26	Rotation rate of radiometer mirror
10	Sampling Frequency	Samples /Sec	B=35	Digital sampling frequency per second of vehicle time
11	Orbit Number	-----	B=35	Orbit Number
12	Station Code	-----	B=35	Data Acquisition Facility (DAF) Station identification
13	Swath Block size	-----	B=35	Number of 36-bit words per swath
14	Swaths/records	-----	B=35	Number of swath per record
15	Number of locator points	-----	B=35	Number of anchor points per swath for which latitudes and longitudes are computed

**Table 2: Nimbus II Orbit Documentation record**

### 7.5 Description of Data Record Documentation

The data record documentation is described in Table 2

Word No.	Quantity	Units	Scaling	Remarks
1D	Nimbus Day	-----	B=17	Start Day of the year for this

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<b>Word No.</b>	<b>Quantity</b>	<b>Units</b>	<b>Scaling</b>	<b>Remarks</b>
				data record
1A	Hour	hh	B=35	Start hour for this data record
2D	Minute	mm	B=17	Start minute for this data record
2A	Second	ss	B=35	Start seconds for this data record
3D	Roll Error	Degrees	B=14	Roll Error at start Date/time (word 1 and 2) for this record
3A	Pitch Error	Degrees	B=32	Pitch Error at start Date/time (word 1 and 2) for this record
4D	Yaw Error	Degrees	B=14	Yaw Error at start Date/time (word 1 and 2) for this record
4A	Height	Km	B=35	Height of the spacecraft at start Date/time (word 1 and 2) for this record
5D	Not used		B=17	Not used
5A	Housing one Temperature	Degrees K	B=32	Measured temperature of housing one at time specified in words one and two
6D	Housing two Temperature	Volts	B=14	Measured temperature of housing two at time specified in words one and two
6A	Electronics temperature	Degrees K	B=32	Measured temperature of electronics at start Date/time (word 1 and 2) for this record
7D	Chopper one Temperature	Degrees K	B=14	Measured temperature of chopper at start Date/time (word 1 and 2) for this record
7A	Chopper one Temperature	Degrees K	B=32	Measured temperature of chopper at start Date/time (word 1 and 2) for this record
8D	GHA of SUN	Degrees	B=14	GHA of Sun of at start Date/time (word 1 and 2) for this record
8A	Dec of SUN	Degrees	B=32	Declination of sun at start Date/time (word 1 and 2) for this record. Ninety degrees added to eliminate negative sign

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Word No.	Quantity	Units	Scaling	Remarks
9	Nadir Angle	Degrees	B=29	Nadir angle corresponding to the first anchor point and measured in the plane of the scanning radiometer
-----				
-----				
N	Nadir Angle	Degrees	B=29	Nadir angle corresponding to the last anchor point and measured in the plane of the scanning radiometer

**Table 3: Nimbus II MRIR Data Record Documentation**

7.6 Description of a Swath Data Record

Word No.	Quantity	Units	Scaling	Remarks
(N+1)D	seconds	ss	B=8	Seconds elapsed since the start of the Date/time of this data record
(N+1)A	Data population	-----	B=35	Number of data points in this swath
(N+2)D	Latitude	Degrees	B=11	Latitude of the subsatellite point for this swath
(N+2)A	Longitude	Degrees	B=29	Longitude of the subsatellite point for this swath, positive westward 0 to 360
(N+3)D	latitude	Degrees	B=11	Latitude of viewed point for the first anchor point
(N+3)A	Longitude	Degrees	B=29	Longitude of viewed point for the first anchor point. Measured westward, 0-360 degrees
-----				
-----				
(N+3+M)D	latitude	Degrees	B=11	Latitude of viewed point for the Mth anchor point
(N+3+M)A	Longitude	Degrees	B=29	Longitude of viewed point for the Mth anchor point

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Word No.	Quantity	Units	Scaling	Remarks
(N+3+M+1)D	MRIR Data	Degrees	B=14	First MRIR temperature measurement , channel 1
(N+3+M+1)A	MRIR Data	Degrees	B=32	First MRIR temperature measurement, channel 1
-----				
-----				
(N+3+M+K)D	MRIR Data	Degrees	B=14	Last MRIR temperature measurement , channel 1
(N+3+M+K)A	MRIR Data	Degrees	B=32	Last MRIR temperature measurement, channel 1
(N+3+M+K+1)D	MRIR Data	Degrees	B=14	First MRIR temperature measurement , channel 2
(N+3+M+K+1)A	MRIR Data	Degrees	B=32	First MRIR temperature measurement , channel 2
-----				
-----				
(N+3+M+2*K)D	MRIR Data	Degrees	B=14	Last MRIR temperature measurement , channel 2
(N+3+M+2*K)A	MRIR Data	Degrees	B=32	Last MRIR temperature measurement , channel 2
-----				
-----				
(N+3+M+4*K+1)D	MRIR Data	Degrees	B=14	First MRIR temperature measurement , channel 5
(N+3+M+4*K+1)A	MRIR Data	Degrees	B=32	First MRIR temperature measurement , channel 5
(N+3+M+5*K)D	MRIR Data	Degrees	B=14	First MRIR temperature measurement , channel 5
(N+3+M+5*K)A	MRIR Data	Degrees	B=32	First MRIR temperature measurement , channel 5

**Table 4: Nimbus II MRIR Swath Data Record**

Note: All remaining or unused portions of a swath data block are set to zero, giving a swath block size as specified in the documentation record.

## 7.7 Quality Assurance Procedures

### 7.7.1 Physical QA

Each restored file was read and its corresponding orbit documentation was extracted and used to derive the file name and to create a XML metadata file.

For each file the number of “bad” records was derived.

Plots of selected swaths were generated (with and without a world map) and some were compared with published papers.

### 7.7.2 Science QA

MRIR data were examined and validated using Nimbus2 MRIR documentation (e.g., The Nimbus II Medium resolution infrared pictorial data catalog, volume 1).

## 7.8 Image Files

The **MRIRN2IM** data product consists of 4 x 5 inch photographic film sheets from the Nimbus-2 Medium Resolution Infrared Radiometer. Each film sheet contains an entire orbit (daylight portion) of data measured at five wavelength bands: 6.4-6.9, 10-11, 14-16, 5-30, and 0.2-4.0 micrometers. There are also associated latitude grids, time, and gray scales representing different temperatures. The images ... are saved as JPEG 2000 digital files. About 3 weeks of images are archived into a TAR file. The processing techniques used to produce the data set and a full description of the data set are contained in section 4.3.4 of the "Nimbus II Users' Guide."

These images can be used to supplement the radiance data files from the **MRIRN3L2** data product. The MRIRN2IM images can be ordered online using the Reverb tool (see section 4 above). The image files can be viewed with any application that supports the JPEG 2000 format.

## 7.9 Acronyms

*DAF*: Data Acquisition Facility

*ECHO*: EOS Clearinghouse

*EOS*: Earth Observing System

*GES DISC*: Goddard Earth Sciences Data and Information Services Center

*GSFC*: Goddard Space Flight Center

*MRIR*: Medium Resolution Infrared Radiometer

*L2*: Level 2 Data

*NASA*: National Aeronautics and Space Administration

*Reverb*: ECHO's Next Generation Metadata and Service Discovery Tool

*QA*: Quality Assessment

*UT*: universal Time