Nimbus Temperature-Humidity Infrared Radiometer 11.5 µm Swath L1, HDF5, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Gallaher, D. and G. Campbell. 2015. *Nimbus Temperature-Humidity Infrared Radiometer 11.5 µm Swath L1, HDF5, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/NIMBUS/NmTHIR115-1H. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NmTHIR115-1H

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DETAILED DATA DESCRIPTION 2
1.1 Format 2
1.2 File Naming Convention 2
1.3 File Size 3
1.4 Spatial Coverage 3
1.4.1 Spatial Resolution 3
1.4.2 Projection and Grid Description 3
1.5 Temporal Coverage 3
1.5.1 Temporal Resolution 3
1.6 Parameter or Variable 3
2 SOFTWARE AND TOOLS 5
3 DATA ACQUISITION AND PROCESSING 5
3.1 Data Acquisition Methods 5
3.2 Derivation Techniques and Algorithms 5
3.2.1 Errors Sources 5
3.3 Quality Assessment 6
3.4 Sensor or Instrument Description 6
3.5 Version History 6
4 REFERENCES AND RELATED PUBLICATIONS 7
4.1 References 7
4.2 Related Data Sets 7
4.3 Related Websites 7
5 CONTACTS AND ACKNOWLEDGMENTS 7
5.1 Investigators 7
5.2 Acknowledgments 8
6 DOCUMENT INFORMATION 8
6.1 Publication Date 8
6.2 Date Last Updated 8

1 DETAILED DATA DESCRIPTION

The THIR detected emitted thermal radiation in two windows: 6.7 µm (6.5 µm — 7.0 µm) and 11.5 µm (10.5 µm — 12.5 µm). Each file in this data set contains 10 minutes of cross-track scan swath data from the 11.5 µm window. The corresponding THIR 6.7 µm window measurements are available as a separate data set here.

WARNING: Simultaneous observations from the 6.7 µm and 11.5 µm windows are typically not available. Although measurements sometimes overlap, most do not.

1.1 Format

Data are provided as HDF5-formatted files. Browse images are also available.

HDF5 is a data model, library, and file format maintained by the HDF Group. For details, visit the HDF Group's HDF5 Home Page.

1.2 File Naming Convention

This section explains the file naming convention used for NmTHIR115-1H data files.

Example File Name: `NmTHIR115-1H.19700413_18-22-34_00074_01.hdf`

`NmTHIR115-1H.[yyyy][mm][dd]_[hh]-[mi]-[ss]_[orb]_[ggg].hdf`

Refer to Table 1 for the valid values for the file name variables listed above.

Table 1. File Name Variable Descriptions

Variable	Description
yyyy	Four-digit year
mm	Month
dd	Day
hh	Hour
mi	Minute
ss	Second
orb	Orbit number
ggg	Granule number (within orbit)

1.3 File Size

Data files typically about 4 MB.

1.4 Spatial Coverage

Coverage is global. However, some regions (parts of Alaska, for example) are not available due to technological limitations and mission objectives at the time.

1.4.1 Spatial Resolution

Approximately 5 km at nadir

1.4.2 Projection and Grid Description

Latitudes and longitudes are provided for each pixel.

1.5 Temporal Coverage

Intermittent data are available from 13 April 1970 to 1 April 1971.

1.5.1 Temporal Resolution

Each file contains 10 minutes of swath data.

1.6 Parameter or Variable

Table 2 lists the variables (data fields) and corresponding attributes stored in NmTHIR115-1H data files. Refer to Table 3 to decode the bit flags stored in the `Flags` variable.

Table 2. NmTHIR115-1H Data Fields and Attributes

Data Field	Description	Attributes	Value
Flags	Bit flags (see Table 3 for descriptions)	Key	bits 0,1: 00=ocean, 01=25% land, 10=50% land, 11=land bit 2: on=ascending, off=descending bit 3: on=day, off=night bit 4: on=bad data due to reflection from spacecraft bit 5: spare bit 6: on=temperature out of range bit 7: spare
		DOI	10.5067/NIMBUS/NmTHIR115-1H

Data Field	Description	Attributes	Value
THIR-115-Temp	Radiative temperatures (K) as derived in the 1960s.	ESDT	Data set short name (NmTHIR115-1H)
		long_ESDT	Data set long name (Nimbus Temperature-Humidity Infrared Radiometer 11.5 µm Swath L1, HDF5)
		units	kelvin
Sat Latitude	Satellite latitude (at nadir) when scan line was acquired	units	degrees
Sat Longitude	Satellite longitude (at nadir) when scan line was acquired	units	degrees
cosine sun zenith angle	Cosine sun zenith angle from satellite nadir	units	1
cosine view angle	Cosine view angle of observation	units	1
latitude	Observation latitude	units	degrees_north
longitude	Observation longitude	units	degrees_east
scan Time millisec	Time scan line was acquired (ms since 1970)	units	millisecond
shift value	Spatial shift (pixels) applied to each scan line to help offset random alignment errors. See section 3.2	units	pixels

Table 3. Bit Flags Descriptions Bit(s)

Bit(s)	Description
0, 1	Ocean/Land Coverage Flag: 00=ocean, 01=25% land, 10=50% land, 11=land
2	Ascending/Descending Half of Orbit: 0=descending; 1=ascending
3	Day/Night Flag: 0=night, 1=day
4	Reflected Light. Flag set to on means bad data due to reflected light from satellite component.
5	Spare. Set to 0.
6	Data Out of Range. Flag set to on means T < 190 K or T > 330 K.
7	Spare. Set to 0

2 SOFTWARE AND TOOLS

HDF-compatible software packages, such as HDFView and Panoply, can be used to read, extract, and display HDF5-formatted files.

3 DATA ACQUISITION AND PROCESSING

3.1 Data Acquisition Methods

The THIR on the Nimbus 4 satellite transformed measured radiation into electrical voltages that were recorded on tape and played back when the satellite came within range of a receiving station. These data were then transmitted to the Goddard Space Flight Center (GSFC), where they were calibrated, converted to temperatures, and archived on 7-track, digital magnetic tapes. In 2013, the contents of these tapes were recovered and written to a binary tape emulation file format (TAP) for preservation. GES DISC, the NASA Goddard Earth Sciences Data and Information Services Center, maintains a Nimbus Overview page through which users can obtain the TAP files and historical Nimbus documentation such as instrument user guides and mission reports.

3.2 Derivation Techniques and Algorithms

In the original THIR data, cloud edges and land features appear jagged. Closer inspection reveals that adjacent scan lines appear to be shifted relative to each other by plus or minus several pixels in the cross-track direction. These small, random shifts likely reflect some kind of systemic error, due perhaps to repeatedly switching data acquisitions on and off to record only the earthward-facing portion of each scan mirror revolution.

To help minimize this error, reference scan lines were created by smoothing the data with a moving average (n=5). Each unsmoothed scan line was then incrementally shifted in the cross-track direction (maximum of ±10 pixels) and correlated at each step with its smoothed counterpart. Data from the original THIR files were then written to the THIR-115-Temp data field, offset by the pixel value that yielded the best correlation. Emptied pixels at the ends of scan lines were filled with a value of 3.4028235E+38. Each scan line's pixel shift is recorded in the shift value data field (see Table 2).

3.2.1 Errors Sources

This data set was constructed from TAP files archived by GES DISC. As such, the data reflect the original THIR calibration and temperature conversion utilized in 1970. From a qualitative review of

images over the poles, it is clear measurements at the low end of the temperature scale contain significant random noise.

3.3 Quality Assessment

The realignment described in the preceding section improves the visual appearance of the data and better represents the shapes of clouds and coastlines. In regions with very little spatial information, for example where the measurements are very noisy or very uniform, the shifts offer little or no improvement.

3.4 Sensor or Instrument Description

The Nimbus 4 Temperature-Humidity Infrared Radiometer (THIR) was a two-channel scanning radiometer designed to detect emitted thermal radiation in two windows: 6.7 µm (6.5 µm — 7.0 µm) and 11.5 µm (10.5 µm — 12.5 µm). The 6.7 µm window operated primarily at night and was used to map the distribution of water vapor in the upper troposphere and stratosphere. The 11.5 µm channel operated both day and night and measured cloud top or surface temperatures.

The Nimbus 4 instrument utilized a single scan mirror which rotated at 48 rpm and was inclined 45° to the axis of rotation to scan perpendicular to the flight path. The field of view scanned across the earth from east to west in daytime and west to east at night, traveling northward and southward respectively. Incoming energy was collected by the mirror and then focused into a dichromatic beam splitter which divided the energy spectrally and spatially into the two channels. Both channels transformed the received radiation into an electrical (voltage) output with an information bandwidth of 0.5 Hz to 120 Hz for the 6.7 µm channel and 0.5 Hz to 360 Hz for the 11.5 µm channel. The data were recorded on tape and subsequently played back to a ground acquisition station.

The THIR intially operated successfully but failed on January 11, 1971 (orbit 3731). It was restarted several times thereafter for very short periods before finally ceasing all operations in August 1971. For additional information about the Nimbus THIR, see the NASA National Space Science Data Center Temperature-Humidity Infrared Radiometer (THIR) Web page.

3.5 Version History

Table 4. Version History

Version (Date)	Details
V1 (24 November, 2015)	Initial release.

4 REFERENCES AND RELATED PUBLICATIONS

4.1 References

Gallaher D., G. G. Campbell, W. Meier, J. Moses, and D. Wingo. 2015. The process of bringing dark data to light: The rescue of the early Nimbus satellite data. *GeoResJ* 6: 124-134. doi:10.1016/j.grj.2015.02.013.

Gallaher, D., G. G. Campbell, and W. Meier. 2014. Anomalous Variability in Antarctic sea ice extents during the 1960's with the use of Nimbus Satellite data. *Journal of Selected Topics in Applied Earth Observations and Remote Sensing*. 7(3): 881-887. doi:10.1109/JSTARS.2013.2264391.

Meier, W. N., D. Gallaher, and G. G. Campbell. 2013. New Estimates of Arctic and Antarctic Sea Ice Extent During September 1964 from Recovered Nimbus I Satellite Imagery. *The Cryosphere Discuss* 7:35-53. doi:10.5194/tcd-7-35-2013.

Sabatini, R.R. 1970. *Nimbus IV User's Guide*. NASA Goddard Space Flight Center, Geenbelt, MD. https://acdisc.gesdisc.eosdis.nasa.gov/data/s4pa/Nimbus4_THIR_Level2/THIRN4L2CH115.001/doc/NimbusIVUG.pdf. 16 June, 2015.

4.2 Related Data Sets

See the Nimbus Data Rescue Project | Data Sets page.

4.3 Related Websites

NASA Goddard Earth Sciences Data and Information Services Center | Nimbus Overview
NASA Goddard Earth Sciences Data and Information Services Center | Nimbus Documentation
NASA Goddard Earth Sciences Data and Information Services Center | Nimbus 4 THIR
NASA Science | Missions | Nimbus

5 CONTACTS AND ACKNOWLEDGMENTS

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5.2 Acknowledgments

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6 DOCUMENT INFORMATION

6.1 Publication Date

November 2015

6.2 Date Last Updated

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