Data Set Documentation

NOAA/NASA SSM/I Pathfinder Level 2 and Level 3 Land Surface Products

Summary

The Pathfinder Program, sponsored by the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA), is tasked to produce long-term data sets for global change research. The Special Sensor Microwave/Imager (SSM/I) Pathfinder Level 2 Land Products data set has been generated using the land classification algorithms developed by Neale, and the land surface temperature algorithms developed by McFarland. This data set includes both the land classification and land surface temperature products. The Pathfinder Level 2 Land Products data set is in swath format. Coverage of the global land surface is daily and spans 1 August 1987 through 31 December 1988. Data are available via ftp on request. The SSM/I Pathfinder Level 3 Land Products data set has been generated using the Level 2 data described above. The Level 2 data were interpolated to a longitude-latitude grid with a resolution of one degree. For the Benchmark Period, the data were averaged over periods of five days (a pentad) or one month, although, for the land classification product, the most commonly occurring land class (the mode of the distribution within each bin) was chosen as the class for that bin and for the period. The data set, including both pentad and monthly grids, covers 1 August 1987 through 31 December 1988. See also Antenna Temperatures.

Table of Contents

1.Data Set Overview

Data Set Identification

NOAA/NASA Pathfinder Level 2 and Level 3 Land Products from DMSP F-8.

Data Set Introduction

This data set is archived and distributed by the National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center (DAAC). The NOAA/NASA Pathfinder SSM/I Level 2 Land Products data set was created using the NOAA/NASA Pathfinder SSM/I data set that contains antenna temperature data as input. Each SSM/I Pathfinder Land Products file begins with the first scan after 00:00:00 UTC and contains all data up to 23:59:59 UTC. The files are in Hierarchical Data Format (HDF). The file size for an uncompressed SSM/I Pathfinder daily Land Products file is 16 megabytes. The NOAA/NASA Pathfinder SSM/I Level 3 Land Products data set is created using the NOAA/NASA Pathfinder SSM/I Level 2 Land Products data set, which is based on full resolution land classification and land surface temperature input data. Each SSM/I Pathfinder Land Products file begins with the first scan after 00:00:00 UTC of the first day of the gridding period and contains all data up to 23:59:59 UTC of the last day of the gridding period. The gridding period may be either a calendar month or a pre-determined group of five days within the year, known as a pentad. The files are in Hierarchical Data Format (HDF). The file size for an uncompressed SSM/I Pathfinder gridded precipitation rate file is about 1.6 megabytes.

Objective/Purpose

The objective of producing the NOAA/NASA Pathfinder SSM/I Level 2 and Level 3 Land Products data set is to provide long-term global data for global change research.

Summary of Parameters

The parameters for the Level 2 Land Products data set are:

- 25-km resolution, swath format Land Classifications
- 25-km resolution, swath format Land Surface Temperature
- File Description
- Latitude Values

- Land Classification Image
- Land Surface Temperature Image

The parameters for the Level 3 Land Products data set are:

- land classification grid, 1 degree longitude-latitude format
- the percent of total pixels grid
- the number of classes grid
- land surface temperature grid, 1 degree longitude-latitude format
- the sum of squares grid
- the number of pixels grid
- file description

Discussion

Each daily land products file begins with the first A scan after 00:00:00 UTC and contains all data up to 23:59:59 UTC. Each file contains land classification, land surface temperature, latitudes, longitudes, A scan start times, orbital elements, and a file description. The algorithms developed by Neale et al. and McFarland et al. are used to compute the land products. The algorithm requires brightness temperatures as input so the Pathfinder antenna temperatures are converted to brightness temperatures using the method supplied by Frank Wentz (1991).

Related Data Sets

No related data sets at this time.

2.Investigator(s)

Investigator(s) Name and Title

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Title of Investigation

NOAA/NASA Pathfinder Special Sensor Microwave / Imager (SSM/I) Level 2 and Level 3 Land Products.

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3.Theory of Measurements

The Land Classification product is defined using statistically determined classification rules. The rules yield up to 12 distinct classifications of land type, not including bad or non-land data. The classes are coded and stored in swath format. These rules consist of various combinations of the seven channels of the SSM/I, depending on satellite and period of time. For the DMSP F-8, the 85 GHz vertical polarization channel eventually became undependable; thus after March 1988, an algorithm which did not depend upon that channel had to be used. After January 1989, the horizontal polarization 85 GHz channel became unreliable; this period, however, is beyond the Pathfinder Benchmark Period, and thus beyond the end of our data set.

The Land Surface Temperature product is computed using regression equations developed by McFarland (and further developed by Neale). These are statistically-based equations that use the five low-resolution channels of the SSM/I to compute air temperature near the Earth's surface for certain land classifications. Not all land classes can have a surface temperature computed (e.g., snow surfaces).

question. The land surface temperature values are summed and averaged in each bin for the period in question. No flagged values are used in computing any of the gridded values. Grid boxes with no data are flagged as missing.

4.Equipment

SSM/I Instrument Description

The information marked with an asterisk (*) in Section 5: Equipment, is quoted from: Hollinger, J. P., J. L. Peirce, and G. A. Poe. 1990. SSM/I instrument evaluation. *IEEE Transactions on Geoscience and Remote Sensing*, **28(5):781-790.** The SSM/I consists of an offset parabolic reflector illuminated by a corrugated broad-band, seven port horn antenna. The reflector and feed-horn antenna are mounted on a drum which contains the radiometers, digital data subsystem, mechanical scanning subsystem, and power subsystem. The entire reflector, feed horn, and drum assembly is rotated about the axis of the drum by a coaxially mounted bearing and power transfer assembly (BAPTA). All data, commands, timing and telemetry signals, and power pass through it on slip ring connectors to the rotating assembly. *

Collection Environment

The SSM/I is a passive microwave sensor aboard the operational DMSP F-8 polar orbiting satellite.

Platform

The DMSP Block 5D-2 F-8 spacecraft flies in a near polar sun-synchronous orbit. Launched on 18 June 1987, the satellite completes 14.1 revolutions per day, the subsatellite ground track repeats approximately every 16 days.

Platform Mission Objectives

The mission of the DMSP is to provide global, visual and infrared cloud data and other specialized near real-time meteorological, oceanographic and solar-geophysical data required to support worldwide Department of Defense operations and high-priority programs. Timely data are supplied to Air Force Global Weather Central (AFGWC), the Navy Fleet Numerical Meteorology and Oceanography Center (FNMOC) and to deployed tactical receiving terminals worldwide.

Key Variables

The SSM/I is a seven-channel, four-frequency linearly polarized passive microwave radiometric system. The instrument measures atmospheric/ocean surface brightness temperatures at 19.3, 22.2, 37.0 and 85.5 GigaHertz (GHz).

Principles of Operation

For a description of the principles of operation, please refer to the SSM/I instrument document.

Instrument Measurement Geometry

The SSM/I rotates at a uniform rate making one revolution in 1.9 seconds, during which time the satellite advances 12.5 km. The antenna beams are at an angle near 45 degrees to the BAPTA rotational axis, which is normal to the Earth's surface. Thus, as the antenna rotates, the beams define the surface of a cone and, from the orbital altitude of 833 km, make an angle of incidence of 53.1 degrees at the Earth's surface. The scene is viewed over a scan angle of 102.4 degrees centered on the ground track aft of the satellite, resulting in a scene swath width of 1394 km.

Manufacturer of Instrument

The SSM/I was built by Hughes Aircraft Company under the direction of the Naval Space Systems Activity and the Air Force Space Division.

SSM/I Calibration

A small mirror and hot reference absorber are mounted on the BAPTA and do not rotate with the drum assembly. They are positioned off-axis such that they pass between the feed horn and the parabolic reflector, occulting the feed once each scan. The mirror reflects cold sky radiation into the feed thus serving, along with the hot reference absorber, as calibration references for the SSM/I.* This scheme provides an overall absolute calibration which includes the feed horn. Corrections for spillover and antenna pattern effects from the parabolic reflector are incorporated in the data processing algorithms.

5.Data Acquisition Methods

The Antenna Temperature (TA) data used for the SSM/I Pathfinder Project are provided by Remote Sensing Systems of Santa Rosa, California and are originally derived from the Temperature Data Records (TDR) processed at the FNMOC in Monterey, California. These data were processed at Marshall Space Flight Center to create the NOAA/NASA SSM/I Pathfinder TA data set, which was then used to create the NOAA/NASA SSM/I Pathfinder Level 2 Land Products data set, using the Neale and McFarland algorithms. The SSM/I Pathfinder Level 2 Land Products data set is then used to generate the NOAA/NASA SSM/I Pathfinder Level 3 Land Products data set. The Level 2 output is binned, averaged, and flagged as describe in Section 3. Theory of Measurements. For details on the processing of these data sets, see the Introduction to the NOAA/NASA SSM/I Pathfinder Land Products Data Set.

6.Observations

Data Notes

No notes at this time.

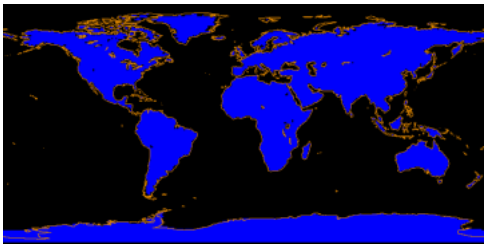
Field Notes

No field notes.

7.Data Description

Spatial Characteristics

Spatial Coverage Map



Spatial Resolution

The Pathfinder Level 2 Land Products data set has been produced at full resolution (25 km). The Pathfinder Level 3 Land Products data set has been produced at a resolution of 1 degree in latitude and longitude.

Projection

The Pathfinder Level 2 Land Products data set has been produced in swath format. The Pathfinder Level 3 Land Products data set has been produced in a "cylindrical", Cartesian projection.

Grid Description

The Pathfinder Level 3 Land Products data set uses an "equal-angle" (longitude-latitude) grid with each grid corresponding to an equal interval of latitude and longitude.

Temporal Characteristics

Temporal Coverage

Both data sets cover 1 August 1987 to 31 December 1988, which includes the Pathfinder Benchmark Period (1 August 1987 to 30 November 1988). On December 3, 1987, the F-8 SSM/I instrument was turned off due to overheating. It was turned on again on January 13, 1988. No data was taken during this period, and thus neither data set contains products from this period. Several other small gaps are also in the data. Refer to Introduction to the NOAA/NASA SSM/I Pathfinder Land Products Data Set for more information about gaps in the data.

Temporal Resolution

The Level 2 data set is available at a resolution of one day. The Level 3 Pentad data set is available at a resolution of 5 days. The Level 3 Monthly data set is available at a resolution of one month.

Data Characteristics

Parameter/Variable

Land Classification, unitless (each possible class is represented by a coded value). Land Surface Temperature, Kelvins (for Level 2 and Level 3 data).

Variable Description/Definition

The land classification is a coded value which is used to represent a pre-defined land class. These classes are used to describe the state of the Earth's surface at specified locations; they are also used to determine whether a surface temperature should be calculated for that location. The land surface temperature is measured in Kelvins, and is computed by regression equations for some of the land classes. Values computed are interpreted as the air temperatures near the Earth's surface, rather than ambient air temperatures, at each location.

Unit of Measurement

For the Level 2 and Level 3 Land Products data sets, the units are land classification (unitless) and land surface temperature (Kelvins).

Data Source

The data from which the Pathfinder Level 2 Land Products data are generated come from the DMSP F-8 SSM/I.

Data Range

For the Level 2 and Level 3 Land Products data sets, the range of values for the land classification is 0 to 25; no boundaries are placed upon the temperature values - any value greater than 0.0 Kelvins is possible, although values less than 220 K and greater than 325 K are unlikely.

Sample Data Record

For a description of the object types included in the Level 2 and Level 3 Land Products HDF files, refer to the Introduction to the NOAA/NASA SSM/I Pathfinder Land Products Data Set.

8.Data Organization

Data Granularity

A general description of data granularity as it applies to the IMS appears in the EOSDIS Glossary as the smallest aggregation of data which is independently managed (i,e., described, inventoried, retrievable). Granules may be managed as logical granules and/or physical granules. Source: ESADS, EPO For the Level 2 products, data are stored in daily files by orbit. The DMSP satellite completes just over 14 orbits each day. An orbit is defined as starting when the satellite crosses the equator going from south to north. Since (swath) data are stored by time, it's possible to have a fraction of an orbit before the first and last full orbits in a particular day's file. Missing data is flagged, such that any data falling on the previous or following days (before 00:00:00 or after 23:59:59 UTC of the current day) will not be present and the scan position will be filled with a missing data flag. For the Level 3 products, data are stored as grids to which all orbits for a given period (i.e., either a pentad or a month) have been mapped.

9.Data Manipulations

Formulae

For a complete list of the rules for determining land classification (as well as the regression equations used for computing land surface temperature), see the Introduction to the NOAA/NASA SSM/I Pathfinder Land Products Data Set: Appendix 1.

Data Processing Sequence

Processing Steps

The antenna temperature data are read into the processing software and brightness temperatures are computed for all channels (beyond March 1988, a synthetic Tb for the 85 GHz vertical channel is computed, using an equation developed at Hughes). Once this has been completed, the Tb's are used to compute a set of values such as polarization differences. These values are subjected to a set of discriminants to determine the land classifications. A land surface temperature is computed for only those pixels with the proper land classification (e.g., "flooded", and "snow" are two classes which do not have a surface temperature associated with them). These data are then used to create the Level 3 Land Products data. The land classifications and land surface temperatures are interpolated to a 1 degree latitude-longitude grid, and are computed as described in Section 3: Theory of Measurements. A more detailed discussion of the processing sequence can be found in the Introduction to the NOAA/NASA SSM/I Pathfinder Land Products Data Set.

Processing Changes

No changes have been made to the processing sequence.

Calculations

Special Corrections/Adjustments

No enhancements were made to the algorithm, except to enable the algorithm to accept the NOAA/NASA Pathfinder Antenna Temperature data set as input.

Calculated Variables

The antenna temperatures of the Pathfinder Daily Antenna Temperature data set are first converted to brightness temperatures (TB's) using the method developed by Frank Wentz (1991).

Graphs and Plots

No graphs or plots are available.

10.Errors

Sources of Error

No information on error sources is available at this time.

Quality Assessment

Data Validation by Source

Studies have been conducted by the algorithm developer regarding the validity of the algorithms. Refer to the list of references available in Introduction to the NOAA/NASA SSM/I Pathfinder Land Products Data Set for information on the data validation.

Confidence Level/Accuracy Judgment

The Pathfinder Team believes this data set to be an accurate representation of the algorithm as developed by Dr. Christopher Neale of Utah State University.

Measurement Error for Parameters

There is no other data about the measurement error at this time.

Additional Quality Assessments

The algorithm was implemented to use SSM/I Pathfinder Antenna Temperature data sets as input, and the Level 2 and Level 3 output were reviewed by Dr. Neale to ensure that the algorithm had been properly implemented.

Data Verification by Data Center

The Pathfinder Level 2 and Level 3 Land Products data have been through a rigorous quality control procedure, and both data sets are judged to be accurate representations of the algorithm. For details, contact NSIDC User Services.

11.Notes

Limitations of the Data

The land classification rules were primarily designed to screen pixels for land surface temperature computations; thus the classification scheme is not as detailed as schemes derived using several other available algorithms.

Known Problems with the Data

Usage Guidance

See Section 11.2 Known Problems with the Data above for usage guidance.

Any Other Relevant Information about the Study

No other information at this time.

12.Application of the Data Set

Applications of this data set include monitoring land uses, monitoring land surface changes and monitoring the impact of land surfaces changes on global temperature distribution.

13.Future Modifications and Plans

No plans exist for further production of this data set at this time.

14.Software

Software Description

Three pieces of software are sent with the Level 2 Precipitation Rate data as utilities to aid in handling the data within the files. The routines are "extractlp.c", "getorblp.c", and "getfiledesc_lp.c". A makefile is also sent along to compile this software. The user will also need to access NCSA's HDF library software, which is free from NCSA via ftp. An Introduction to the NOAA/NASA SSM/I Pathfinder Land Products Data Sets is also distributed with the data to assist the user in understanding the files and the data. Two pieces of software are sent with the Level 3 Precipitation Rate data as utilities to aid in handling the data within the files. The routines are "extractlg.f", and "getfiledesc.c". A makefile is also sent along to compile this software. The user will also need to access NCSA's HDF library software, which is free from NCSA via ftp. An Introduction to the NOAA/NASA SSM/I Pathfinder Pentad and Monthly Land Products Data Sets is also distributed with the data to assist the user in understanding the files and the data.

Software Access

To access information at NCSA about how to use and how to retrieve the HDF libraries, see the NCSA home page or see the Introduction to the NOAA/NASA SSM/I Pathfinder Pentad and Monthly Land Products Data Sets.

15.Data Access

Contact Information

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Data Center Identification

National Snow and Ice Data Center Distributed Active Archive Center.

Procedures for Obtaining Data

To request a copy of the data, please contact NSIDC User Services. Also, these data are available via the EOSDIS V0 Information Management System (IMS) (telnet eosims.colorado.edu 12345).

Data Center Status/Plans

The NOAA/NASA SSM/I Pathfinder Land Surface data are available for the period from 1 August 1987 to 31 December 1988. There are no plans to produce this data beyond the end of 1988.

16.Output Products and Availability

Tape Products

Data sets are provided via ftp by request.

17.References

Satellite/Instrument/Data Processing Documentation

- **Hollinger, J. P., R. Lo, G. Poe, R. Savage, and J. Peirce. 1987.** Special Sensor Microwave/Imager User's Guide.
- **Hollinger, J. P., ed. 1989.***DMSP Special Sensor Microwave/Imager Calibration/Validation - Final Report - Volume I*, Naval Research Laboratory, Washington, DC.

- **McFarland, M. J., and C. Neale. 1991.** Land Parameter Algorithm Validation and Calibration. *DMSP Special Sensor Microwave/Imager Calibration/Validation - Final Report, Volume II*, Naval Research Laboratory, Washington, DC, chap 9, pp 1-64.
- **McFarland, M.J., R. L. Miller, and C. M. U. Neale. 1990.**Land Surface Temperature Derived From the SSM/I Passive Microwave Brightness Temperatures. *IEEE Transactions on Geoscience and Remote Sensing* , **28**(5):839-845.
- **Neale, C.M.U., M.J. McFarland, and K. Chang. 1990.**Land Surface-Type Classification Using Microwave Brightness Temperatures From The Special Sensor Microwave/Imager. *IEEE Transactions on Geoscience and Remote Sensing*, **28**(5):829-838.
- **Hollinger, J. P., J. L. Peirce, and G. A. Poe. 1990.** SSM/I Instrument Evaluation. *IEEE Transactions on Geoscience and Remote Sensing,* **28**(5):781-790.

18.Acronyms and Abbreviations

The following acronyms and abbreviations are used in this document.

HDF	Hierarchical Data Format
TA	Antenna Temperature
TB	Brightness Temperature

19.Document Information

Document Revision Date (MSFC)

October 23, 1995

Document Revision Date (NSIDC)

February 6, 1997

Document Review Date (MSFC)

October 17, 1995

Document Review Date (NSIDC)

January 28, 1997

Document ID

This information is not available at this time.

Citation

As a condition of using these data, you must cite the use of this data set using the following citation. For more information, see our Use and Copyright Web page.

Neale, C. M.U. and M. J. McFarland. 2003. *DMSP-F8 SSM/I Pathfinder Land Surface Products*. [indicate subset used]. Boulder, Colorado USA: NASA DAAC at the National Snow and Ice Data Center.

Document Curator

NSIDC Writers

Document URL

http://nsidc.org/data/docs/daac/nsidc0042_ssmi_land.gd.html