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

README Document for Chang Special Sensor Microwave/ Imager (SSM/I) Monthly Rain Indices Data Set

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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:

Zhong Liu

Name
GES DISC
GSFC Code 610.2

Collaborator's Name

Name
Collaborator Address

March 26, 2021

Date

Reviewed By:

Reviewer Name

Reviewer Name
GES DISC
GSFC Code 613.2

Date

Date

Goddard Space Flight Center
Greenbelt, Maryland

Revision History

Revision Date	***Changes***	***Author***
June 17, 2016	This document was first created	Zhong Liu
October 5, 2016	More contents were added	Zhong Liu
March 26, 2021	GES DISC Help Desk new email address; http in the footer; data policy URL	Zhong Liu

Table of Contents

Contents

1.0 Introduction

This document provides basic information for using Chang Special Sensor Microwave/ Imager (SSM/I) Monthly Rain Indices Data Set product.

The Chang SSM/I Monthly Rainfall Indices were generated using the SSM/I brightness temperatures from the DMSP satellites F8 and F11. The data set contains gridded ocean monthly total rainfall indices. The data are on a 5 x 5 degree grid covering the area from 50N to 50S and 180E to 180W. Each grid cell value is the average of the satellite's ascending and descending estimates, corrected for beam fillings errors. Grid values are computed only over the oceans.

The data is binned into months using the Global Precipitation Climate Project (GPCP) convention. Using this convention, each month consists of six pentads (30 days total) except for August which contains seven pentads (35 days total).

1.1 Dataset/Mission Instrument Description

The SSM/I Monthly Rainfall Indices data set contains gridded ocean monthly total rainfall indices in millimeters. A Probability Distribution Function (PDF) method (Wilheit et al. (1991) and Chang et al. (1993)) was used to derive the monthly rain indices. The temporal coverage for the data set is from July 1987 through December 1995. However, no data are available for December 1987, because the instrument was turned off during that time period. Brightness temperatures were obtained from the SSM/I aboard the DMSP F8 platform from July 1987 through December 1991, and from the SSM/I aboard the DMSP F11 from January 1992 through December 1995.

Basic characteristics:

Variable name: Accumulated surface precipitation (monthly means)

Units: mm/month

Date range: July 1987 - December 1995

Spatial coverage: 50° N to 50° S; 180° W to 180° E

Spatial resolution: 5° x 5°

File size: 1.18 Mb

Format: ASCII

1.1.1 Dataset/Instrument

The Defense Meteorological Satellite Program (DMSP) Block 5D-2 spacecrafts fly in a near polar sun-synchronous orbit. The satellites complete 14.1 revolutions per day and the subsatellite ground track repeats approximately every 16 days.

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

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 of 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 approximately 1400 km.

The SSM/I instrument consists of an offset parabolic reflector that is 24 x 26 inches fed by a seven- port horn antenna. The reflector and feed are mounted on a drum which contains the radiometers, digital data subsystem, mechanical scanning subsystem and power subsystem. The drum assembly rotates about the axis of the drum. A small mirror and a hot reference absorber are mounted on the assembly.

The instrument sweeps a 450 cone around the satellite velocity vector so that the Earth incidence angle is always 540. Data are recorded during the 102.40 of the cone when the antenna beam intercepts the Earth's surface. The channel footprint varies with channel energy, position in the scan, along scan or along track direction and altitude of the satellite. The 85 GHz footprint is the smallest with a 13 x 15 km and the 19 GHz footprint is the largest at 43 x 69 km. Because the 85 GHz footprint is so small, it is sampled twice as often, i.e., 128 times a scan. One data cycle consists of 4 85 GHz scans and 2 scans of the 19, 22 and 37 GHz channels. The complete cycle takes 28 seconds and it must be complete to process the data.

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 of 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 approximately 1400 km.

According to Wentz (1988), the absolute brightness temperature of the scene (TB) incident upon the antenna is received and spatially filtered by the antenna to produce an effective input signal or antenna temperature (TA) at the input of the feedhorn antenna. The procedure for deriving Earth antenna temperatures is discussed below.

In computing the SSM/I antenna temperatures, the basic assumption is that the radiometer output voltage is linearly related to the input power at the mixer/preamplifier. Nonlinear effects such as imperfections in the square-law detector and Intermediate Frequency (IF) amplifier compression are assumed negligible. Expressing the input power in terms of radiation temperature gives

$$V(i) = ckBg(TA(i) + TN) \qquad (1)$$

where V(i) is the radiometer output voltage, TA(i) (Kelvin) is the radiation temperature entering the feedhorn, and TN (Kelvin) is the radiometer noise temperature. The constants are c = detector constant, k = Boltzmann constant, B = receiver predetection bandwidth, and g = receiver gain. The subscript i denotes either a cold-space observation (i = C), a hot-load observation (i = H), or an Earth observation (i = E). The gain and noise temperature are assumed stable over the period of one scan, which is 1.9 seconds. That is to say, g and TN are assumed to be the same for the cold-space, hot-load, and Earth observations. The output voltage (V) is converted to counts (C) by applying a scaling factor (w) and a constant offset (P):

$$C(i) = wV(i) - P \qquad (2)$$

Combining (1) and (2) for i = C, H, and E gives

$$TA(E) = A * C(E) + B \qquad (3)$$

$$A = (TA(H) - TA(C)) / (C(H) - C(C)) \quad (4)$$

$$B = ((TA(C) * C(H)) - (TA(H) * C(C))) / (C(H) - C(C)) \quad (5)$$

For each SSM/I scan, five cold counts and five hot counts are recorded for each channel. (Only 85 GHz observations are taken on the B-scans). The quantities C(C) and C(H) are found by averaging the five individual counts. The cold space antenna temperature TA(C) is set to 2.7 K for all channels. The hot reference antenna temperature is found from

$$TA(H) = T0(H) + 0.01(TO(P) - TO(H)) \qquad (6)$$

where TO(H) and TO(P) are the physical temperatures of the hot load and the radiator plate facing the hot load. The small correction for the radiator plate is to account for radiative coupling between the hot load and the top plate of the rotating drum assembly which faces the hot load. There are three thermistors on the hot load and one on the radiator plate. The temperature T0(H) is found by averaging the three thermistor readings. Thus the A and B coefficients can be computed, and equation (3) can be inverted to recover the original values for the Earth-viewing counts C(E).

1.2 Algorithm Background

A Probability Distribution Function (PDF) method (Wilheit et al. (1991) and Chang et al. (1993)) was used to derive the monthly rain indices.

Limitations of the data: The rainfall indices were computed only over the oceans for this data set. Therefore, this data set should not be used to examine land surface rainfall.

Known problems: There are 33 cells set to -10.0 due to island contamination. Any rain retrieval that did not converge for a given cell results in that cell being set to -10.0.

1.3 Data Disclaimer

1.3.1 Acknowledgement

Please see, https://disc.gsfc.nasa.gov/information/documents?title=data-policy

1.3.2 Contact Information

GES DISC Help Desk:

For assistance with our data and services, please write or call us at:

Email: gsfc-dl-help-disc@mail.nasa.gov

Voice: 301-614-5224

Fax: 301-614-5268

2.0 Data Organization

The data consist of monthly precipitation in mm/month in one ASCII file.

2.1 File Naming Convention

The data are stored in one ASCII file, gpcp_ssmi_1295_5.0_v23

Size: 1.2 Megabytes (ASCII)

2.2 File Format and Structure

The data were mapped to a 5 degree latitude by 5 degree longitude grid for the area from 50 degree north latitude to 50 degree south latitude, and 180 degree west longitude to 180 degree east longitude. The division of the data into months followed the GPCP convention: each month consists of six pentads (30 days) except August, which consists of seven pentads (35 days). For example, June monthly averages contain data from May 31 to June 29, inclusive. Table 1 defines the GPCP pentad months.

Table 1.

Month	Inclusive Dates	Inclusive Julian Days
January	01/01 - 01/30	001 - 030
February	01/31 - 03/01	031 - 060 **
March	03/02 - 03/31	061 - 090
April	04/01 - 04/30	091 - 120
May	05/01 - 05/30	121 - 150
June	05/31 - 06/29	151 - 180
July	06/30 - 07/29	181 - 210
August	07/30 - 09/02	211 - 245
September	09/03 - 10/02	246 - 275
October	10/03 - 11/01	276 - 305
November	11/02 - 12/01	306 - 335
December	12/02 - 12/31	336 - 365

** Note that leap year will have an extra day.

Each grid cell value is the average of the satellite ascending and descending estimates, corrected for beam filling errors. The equation used to calculate the estimates is

$$(\text{ascending} + \text{descending}) / 2.0 * 1.5$$

Values are only computed over oceans; cells over land are set to -10.0. There are also 33 cells set to -10.0 due to island contamination. Any rain retrieval that did not converge for a given cell results in that cell being set to -10.0.

An informational header consisting of 55 ASCII records precedes the actual rainfall data in the file. Following this header are the monthly grids for the entire period of coverage. Each month starts with an ASCII tag that identifies the year and month of the data. Following each tag is a 72 x 20 gridded monthly rainfall array, where 72 is the number of longitude bands and 20 is the number of latitude bands. The gridded rainfall data are stored as real numbers with 144 rows of data values written out as 8-character fields.

Grid (1,1) is defined as the latitude band 45-50N, longitude band 0-5E.The grids progress as described in Table 2, with the longitude bands incrementing first.

Table 2.

Latitude -->	45-50N	40-45N	...	40-45S	45-50S
Longitude					
0- 5E	(1,1)	(1,2)		(1,19)	(1,20)
5-10E	(2,1)	(2,2)		(2,19)	(2,20)
.					
.					
.					
175-180W	(72,1)	(72,2)		(72,19)	(72,20)

2.3 Key Science Data Fields

Accumulated surface precipitation

3.0 Data Contents

3.1 Dimensions

See Sec. 2.

3.2 Global Attributes

See Sec. 2.

3.3 Products/Parameters

Product name: Chang Special Sensor Microwave/ Imager (SSM/I) Monthly Rain Indices

Parameter name: Accumulated surface precipitation

4.0 Options for Reading the Data

4.1 Command Line Utilities

4.1.1 more

more is a command to view (but not modify) the contents of a text file:

$more gpcp_ssmi_1295_5.0_v23

4.1.2 vi

vi is a text editor to view and modify the contents of a text file:

$vi gpcp_ssmi_1295_5.0_v23

4.2 Tools/Programming

An example program in FORTRAN to read the Chang SSM/I rainfall indices is shown below:

```
real precip (72, 20)
      character*50 infile, yyymmm*6, info(55)*80
      data infile / 'GPCP_SSMI_1295_5.0_v23' /
      open (unit=20, file=infile, form='formatted',
     +      access='sequential', status='readonly')
      read (20, '(a)') info
      do 200 irec=1, 150
        read (20, 1000, end=9999) yyymmm, precip
          write (6, *) ' Data read for time period ', yyymmm
  200 continue
 1000 format (1x, a6 / (10f8.1))
 9999 write (6, *) ' End of file reached '
      stop
      end
```

5.0 Data Services

If you need assistance or wish to report a problem:
Email: gsfc-dl-help-disc@mail.nasa.gov
Voice: 301-614-5224
Fax: 301-614-5268
Address:

Goddard Earth Sciences Data and Information Services Center NASA Goddard Space Flight Center Code 610.2 Greenbelt, MD 20771 USA

6.0 More Information

N/A

7.0 Acknowledgements

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References

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