updated to v5.222B
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Earth Observation Research Center
Japan Aerospace Exploration Agency

Global Satellite Mapping of Precipitation Gauge-calibrated Product (GSMaP_Gauge) Data Format Description for Product Version 5

This document describes data format and information of Global Satellite Mapping of Precipitation Gauge-calibrated product (hereafter refers as GSMaP_Gauge) for product version 5. GSMaP_Gauge were developed based on activities of the GSMaP (Global Satellite Mapping of Precipitation) project, which are promoted by the JAXA Precipitation Measuring Mission (PMM) Science Team.

1. Products Overview

Table 1 Summary of GSMaP_Gauge Products

No	Parameter [unit]	Data format	Coverage	Grid size	Horizontal resolution	Temporal resolution	Section
1	Hourly Rain Rate [mm/hr]	4-byte float plain binary, little-endian	Global (60°N-60°S)	3600 x 1200	0.1 x 0.1 degree grid box	Hourly	See Section 3

2. Product/Algorithm Versions and Data Period

2.1. Version

Version of product and algorithms are denoted in following format.

Version: v**P**.**RSK.I.J**

where;

- **P**: product version;
- **R**: version of microwave imager algorithm (reset when product version is updated);
- **S**: version of microwave sounder algorithm (reset when product version is updated);
- **K**: version of microwave-IR combined algorithm; and
- **I**: inclement number of GSMaP_MVK reprocessing.
- **J**: inclement number of GSMaP_Gauge reprocessing.

Latest version of GSMaP_Gauge is v5.222.1.40, indicates that product version is **5**, microwave imager algorithm version is **5.2**, microwave sounder version is **5.2**, microwave-IR combined version is **2,** and inclement number of reprocessing is **1**.

Product version will be updated only when there are major updates in algorithms and reprocessing of whole period is done.

2.2. Data Period

Data period for product version 5 is from **2 March 2000 to 30 November 2010** (data period will extend later).

2.3. FTP/web server

Password protected ftp server same as GSMaP Near Real Time Version (GSMaP_NRT).

3. Hourly Rainfall and Flag Files in Binary (products (1))

3.1. Basic Information

Temporal resolution: 1 hour (hourly data).

Grid resolution: 0.1 degrees latitude/longitude grid (10km at the equator).
Latitude and longitude of the first grid [1, 1] is [59.95°N, 0.05°E].

Domain: Global (60°N-60°S).

3.2. FTP Directory Information

Hourly Rain Rate data; /standard_gauge/v5/hourly/**YYYY**/**MM**/**DD**/

where;

YYYY: 4-digit year;
MM: 2-digit month; and
DD: 2-digit day.

3.3. File Naming Rules

Data and flag files are named according to the following rules;

Hourly Rain Rate data: gsmap_gauge.**YYYYMMDD**.**HHNN**.v**P.RSK**.**I.J**.dat

where;

YYYY: 4-digit year;
MM: 2-digit month;
DD: 2-digit day;
HH: 2-digit hour;
NN: 2-digit minute (currently fixed as 00); and
P.RSK.I.J: version of algorithms (see section 2 for details).

3.4. Data Format

Data format was same as current version of GSMaP_NRT and the GSMaP_MVK(**v5.222.1**). History of version up is described in GSMaP_Gauge_HISTORY.txt file on the ftp server.

All binary files are produced in little-endian byte order platform, and archived with compressed using “gzip”. Grid of those files consists of 3600 rows x 1200 lines, which are longitude-latitude elements corresponding to a 0.1 x 0.1 degree grid that covers the global region from 60°N to 60°S. The center longitude and latitude of the first pixel [1, 1] (left top corner) are [0.05°E, 59.95°N] (Figure 1).

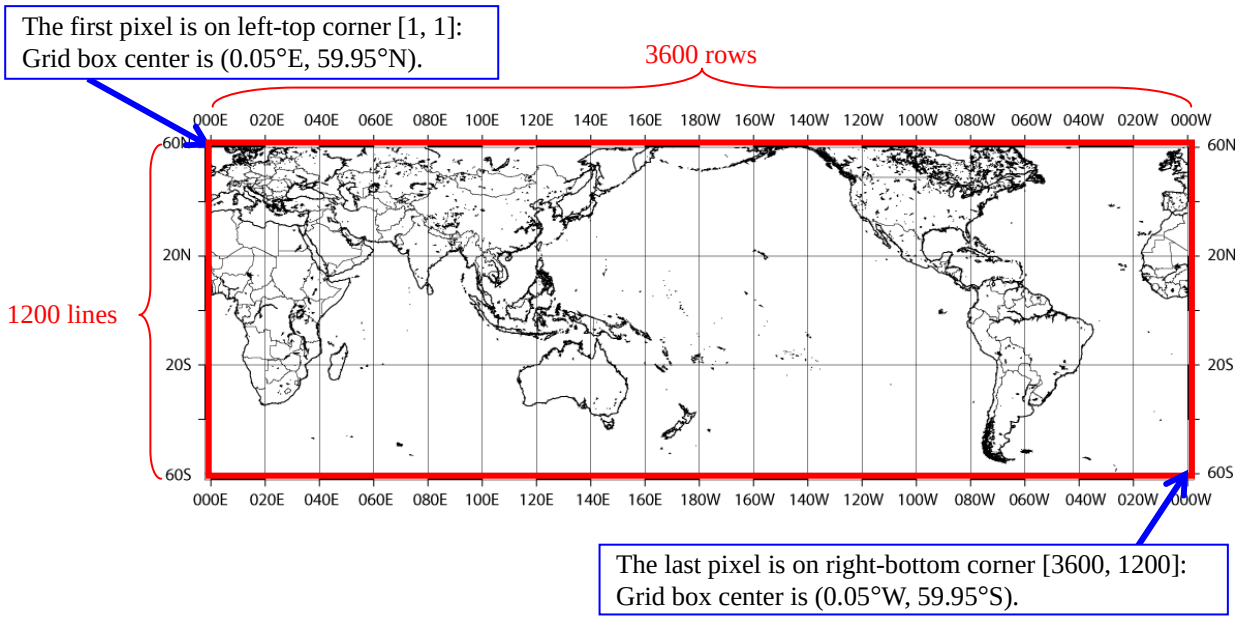

Figure 1 Data Coverage Map (Rain and Flag data)

3.5. Stored Value of Hourly Rain Rate

"Hourly Rain Rate" data are stored in 4-byte float plain binary format. Unit is [mm/hr]. Negative value denotes missing in observation data or no retrieval was done in microwave retrieval algorithm. Detailed description for missing data is shown in Table 2.

Table 2 Stored Value of Hourly Rain Rate

Value	Description
(positive)	Hourly rain rate [mm/hr].
−4	Missing due to sea ice in microwave retrieval algorithm.
−8	Missing due to low temperature in microwave retrieval algorithm.
−99	Missing due to no observation by IR and/or microwave.

3.6. File Size

Approximately 3.0 Mbyte (with gzip), and 17 Mbyte (uncompress) for each file.

4. Sample code

4.1. Sample Code Directory Information

Some sample codes are archived at following directory, because formats are same as in the GSMaP_MVK;

Data files are archived at following directories; `/standard/v5/sample/`

4.2. FORTRAN Sample Code

FORTRAN sample code to read hourly rain rate data (product (1), plain binary) is archived as;

`read_GSMaP_MVK_0.1deg.v5.f`

4.3. IDL Sample Code

Sample code for Interactive Data Language (IDL) to read hourly rain rate data (product (1), plain binary) is archived as;

GSMaP_MVK_sample.v5.pro

4.4. GrADS Control File

Sample control files of the Grid Analysis and Display System (GrADS) for each product are also archived as follows;

Hourly Rain Rate data: GSMaP_MVK.hourly.rain.v5.ctl

About usage of GrADS tool, please see GrADS home page (http://grads.iges.org/grads/head.html).

5. Algorithm and references

5.1. Algorithm

The dataset of "Global Satellite Mapping of Precipitation Gauge-calibrated Product (GSMaP_Gauge)" is Gauge-calibrated version based upon the GSMaP_MVK reanalysis version and the NOAA CPC Gauge-Based Analysis of Global Daily Precipitation. List of papers describing the GSMaP algorithms are also found at Section 5.2 References, below.

5.2. References

Papers describing the GSMaP project and algorithms are as follows.

(About GSMaP_Gauge)

T. Ushio, T. Matsuda, T. Tashima, T. Kubota, M. Kachi, S. Yoshida, 2013: Gauge Adjusted Global Satellite Mapping of Precipitation (GSMaP_Gauge), ISTS paper, 2013-n-48.

(About NOAA CPC Gauge data)

P. Xie, , A. Yatagai, M. Chen, T. Hayasaka, Y. Fukushima, C. Liu, and S. Yang, 2007: A gauge-based analysis of daily precipitation over East Asia, J. Hydrometeorol., 8, 607. 626.

M. Chen, W. Shi, P. Xie, V. B. S. Silva, V E. Kousky, R. Wayne Higgins, and J. E. Janowiak, 2008: Assessing objective techniques for gauge-based analyses of global daily precipitation, J. Geophys. Res., 113, D04110, doi:10.1029/2007JD009132.

M. Chen, , P. Xie, and Co-authors, 2008: CPC Unified Gauge-based Analysis of Global Daily Precipiation, Western Pacific Geophysics Meeting, Cairns, Australia, 29 July - 1 August, 2008.

(About GSMaP project)

K. Okamoto, T. Iguchi, N. Takahashi, K. Iwanami and T. Ushio, 2005: The global satellite mapping of precipitation (GSMaP) project. *25th IGARSS Proceedings*, 3414-3416.

K. Okamoto, T. Iguchi, N. Takahashi, T. Ushio, J. Awaka, S. Shige, and T. Kubota, 2007: High precision and high resolution global precipitation map from satellite data. *ISAP 2007 Proceedings*, 506-509.

T. Kubota, S. Shige, H. Hashizume, K. Aonashi, N. Takahashi, S. Seto, M. Hirose, Y. N. Takayabu, K. Nakagawa, K. Iwanami, T. Ushio, M. Kachi, and K. Okamoto, 2007: Global Precipitation Map using

Satelliteborne Microwave Radiometers by the GSMaP Project : Production and Validation. *IEEE Trans. Geosci. Remote Sens.*, **45(7)**, 2259-2275.

(About microwave imager algorithm)

K. Aonashi, J. Awaka, M. Hirose, T. Kozu, T. Kubota, G. Liu, S. Shige, S., Kida, S. Seto, N. Takahashi, and Y. N. Takayabu, 2009: GSMaP passive, microwave precipitation retrieval algorithm: Algorithm description and validation. *J. Meteor. Soc. Japan*, **87A**, 119-136.

(About microwave sounder algorithm)

S. Shige, T. Yamamoto, T. Tsukiyama, S. Kida, H. Ashiwake, T. Kubota, S. Seto, K. Aonashi and K. Okamoto, 2009: The GSMaP precipitation retrieval algorithm for microwave sounders. Part I: Over-ocean algorithm. *IEEE Trans. Geosci. Remote Sens*, **47**, 3084-3097.

(About microwave-IR combined algorithm)

T. Ushio, T. Kubota, S. Shige, K. Okamoto, K. Aonashi, T. Inoue, N., Takahashi, T. Iguchi, M. Kachi, R. Oki, T. Morimoto, and Z. Kawasaki, 2009: A Kalman filter approach to the Global Satellite Mapping of Precipitation (GSMaP) from combined passive microwave and infrared radiometric data. *J. Meteor. Soc. Japan*, **87A**, 137-151.

(About NRT system)

M. Kachi, T. Kubota, T. Ushio, S. Shige, S. Kida, K. Aonashi, and K. Okamoto, 2011: Development and utilization of "JAXA Global Rainfall Watch" system. *IEEJ Transactions on Fundamentals and Materials*, **131**, 729-737. (In Japanese with English abstract)

T. Ushio, and M. Kachi, 2009: Kalman filtering application for the Global Satellite Mapping of Precipitation (GSMaP). *Chapter for "Satellite Rainfall Applications for Surface Hydrology" (Editedy by Mekonnen Gebremichael and Faisal Hossain)*, Springer, ISBN978-9048129140, 105-123.

Additional related papers are listed on the GSMaP Project Website:
http://sharaku.eorc.jaxa.jp/GSMaP_crest/html/publications.html

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