Version 1.2 GPCP One-Degree Daily Precipitation Data Set Documentation

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What's New!

19 February 2013 The IR input data stream has been restarted and GPCP is now returned to the nominal production schedule, about 2 months after the month of observations. Accordingly, data up through November 2012 are now posted.

18 September 2012 Version 1.2 of the GPCP One-Degree Daily (1DD) combined precipitation data set has been released, superseding all previous versions, including Version 1.1. This upgrade takes advantage of upgrades in most of the constituent datasets, including Version 2.2 of the GPCP monthly SG, an upgrade of the GPROF algorithm to GPROF2004 (used for SSMI and SSMIS), inclusion of the DMSP F17 SSMIS to extend the record past the end of F13 SSMI, and an improved treatment of the data boundary at 40°N and S with a linear taper algorithm. As well, the microwave frequency of precipitation is now computed with only the 6 a.m./p.m. SSMI and SSMIS satellites to achieve a more CDR-like homogeneity. In previous versions, all available microwave satellites were used, potentially creating a heterogeneous record.

1 August 2012 Version 2.2 of the monthly Satellite-Gauge (SG) combined precipitation data set has been released in final form, superseding all previous versions, including Version 2.1 and the provisional 2.2 that was released in July 2011. This upgrade takes advantage of upgrades in many of the constituent datasets, including the Chang/Chiu/Wilheit (CCW) emission and NOAA scattering algorithms, the GPCC precipitation gauge analysis, and inclusion of the DMSP F17 SSMIS. The dataset currently ends in July 2011, with additional months to be released soon as we return to routine production with a latency of about 2 months.

Request to Users

The GPCP datasets are developed and maintained with international cooperation and are used by the worldwide scientific community. To better understand the evolving requirements across the GPCP user community and to increase the utility of the GPCP product suite, the dataset producers request that a citation be provided for each publication that uses the GPCP products. Please email the citation to *george.j.huffman@nasa.gov* or *david.t.bolvin@nasa.gov*. Your help and cooperation will provide valuable information for making future enhancements to the GPCP product suite.

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1. Data Set Names and General Content

The formal **data set name** is the "GPCP One-Degree Daily Precipitation Data Set." It is also referred to as the "1DD Data Set." It is given the version number 1.2.

The data set currently contains a product providing daily, global gridded values of precipitation totals for the period October 1996 through the present, with a 2-3 month delay for data collection and processing.

The main refereed citation for the data set is Huffman et al. (2001; all references are listed in section 13).
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2. Related Projects, Data Networks, and Data Sets

The **data set creators** are G.J. Huffman, D.T. Bolvin, and R.F. Adler, working in the Mesoscale Atmospheric Processes Laboratory, NASA Goddard Space Flight Center, Code 612, Greenbelt, Maryland, 20771 USA, as the GPCP Merge Development Centre.
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The work is being carried out as part of the Global Precipitation Climatology Project (**GPCP**), an international project of the World Meteorological Organization/World Climate Research Programme/Global Energy and Water Experiment (WMO/WCRP/GEWEX) designed to provide improved long-record estimates of precipitation over the globe. The GPCP home page is located at
http://www.gewex.org/gpcp.html
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The 1DD Data Set contains data from several **data providers**:

1. GPCP Geostationary Satellite Precipitation Data Centre (IR Tb histograms),
2. GPCP Merge Development Centre (GPCP SG Merged Precipitation estimate and GPROF2004 SSMI and SSMIS fractional occurrence), and
3. GSFC Satellite Research Team (TOVS and AIRS precipitation estimates).

Some of these data sets extend beyond the 1DD period in their original archival locations.
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There are numerous **similar data sets**, although no other quite matches the attributes of being fully global, available from October 1996, and consistent with the GPCP monthly SG estimates. See *http://www.isac.cnr.it/~ipwg/data/datasets.html* for listings of other precipitation data sets. The closest include the set of estimates based on:

1. TMPA estimates;
2. TMPA-RT estimates;
3. Turk (1999): individual SSMI overpasses calibrate geo-IR precipitation estimates;
4. Sorooshian et al. (2000): the PERSIANN neural network calibrates IR with microwave;
5. Joyce et al. (2004): the CMORPH morphing scheme time-interpolates microwave patterns with IR-based motion vectors; and
6. Kubota et al. (2007): the GSMaP system applies a Lagrangian time-interpolation scheme similar to CMORPH.

Several SSMI-based data sets are available as gridded single-sensor data sets with significant data voids in cold-land, snow-covered, and ice-covered areas, including those computed with the GPROF 6.0, 2004a, and 2010 algorithms (based on Kummerow et al. 1996); the NOAA

Scattering algorithm (Grody 1991); the Chang/Chiu/Wilheit emission algorithm (Wilheit et al. 1991); and the HOAPS algorithm (Andersson et al. 2010) among others. Other daily, single-sensor data sets are available for open-water regions based on SSMI data (Wentz and Spencer 1998), MSU data (Spencer 1993), AMSR-E, and AMSU-B/MHS data. Several daily single-sensor or combination data sets are available at the regional scale, but are not really "similar."
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3. Storage and Distribution Media

The **data set archive** consists of unformatted binary files. The day files are appended into month files that have ASCII headers. The 1DD is distributed by FTP over the Internet. Each month file occupies ~7.4 MB.
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4. Reading the Data

A **data file identifier** is embedded in the data file name as

gpcp_<version>_<variable><technique>.<date>

where

<version>	is a short alphanumeric string giving the version:
	1.2 = Version 1.2
<variable>	is the parameter:
	p = precipitation; TMPI 40ºN-S, AdSND outside that;
	e = random error (currently not produced).
<technique>	is the algorithm:
	1d = 1DD
<date>	is the UTC date as YYYYMMDD (i.e., numerical year, month, day);

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The **data file access technique** is the same for all files in a release. These files are accessible by standard third-generation computer languages (FORTRAN, C, etc.).

Each monthly file consists of a 1440-byte header record containing ASCII characters (which is the same size as one row of data), then a month (28, 29, 30, or 31) of daily grids of size 360x180 containing REAL*4 values. The header line makes the file nearly self-documenting, in particular spelling out the variable and version names, and giving the units of the variable. The header line may be read with standard text editor tools or dumped under program control. All the month's days of data are present, even if some have no valid data. Grid boxes without valid data are filled with the (REAL*4) "missing" value -99999. The data may be read with standard data-display tools (after skipping the 1440-byte header) or dumped under program control.
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The **originating machine** on which the data files where written is a Silicon Graphics, Inc. Unix workstation, which uses the "big-endian" IEEE 754-1985 representation of REAL*4 unformatted binary words. Many CPUs including PCs machines will require a change of representation to "little-endian" before using the data.

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For the monthly files, it is possible to **read the header record** with most text editor tools, although the size (1440 bytes) may be longer than some tools will support. Alternatively, the header record may be dumped out under program control, as demonstrated in the following programming segment. The header is written in a "PARAMETER=VALUE" format, where PARAMETER is a string without embedded blanks that gives the parameter name, VALUE is a string that gives the value of the parameter, and blanks separate each "PARAMETER=VALUE" set. To prevent ambiguity, no spaces or "=" are permitted as characters in PARAMETER, and "=" is not permitted in VALUE. So, a string followed by "=" signals the start of a new metadata group.

The sample FORTRAN software to read the header is read_1dd_v1.2_header.f, and the sample IDL procedure is read_1dd_v1.2_file.pro . See ftp://meso.gsfc.nasa.gov/pub/1dd-v1.2/1dd_v1.2 .software .

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It is possible to **read a day of data**, i.e., one grid of data, with many standard data-display tools. In the monthly file the 1440-byte header is designed to be exactly the size of one row of data, so the header may be bypassed by skipping 1440 bytes or 360 "big-endian" REAL*4 data points or one row. Alternatively, the data may be dumped out under program control as demonstrated in the following programming segment. Once past the header, there is always a month of daily grids. In all cases the grids are of size 360x180 containing REAL*4 values. All days of data in the month are present, even if some have no valid data. Grid boxes without valid data are filled with the (REAL*4) "missing" value 99999. Days in the month that lack data are entirely filled with "missing."

The sample FORTRAN software to read a day of data is read_1dd_v1.2_day.f. The sample IDL procedure to read all days in the month file is in read_1dd_v1.2_file.pro. See ftp://meso.gsfc.nasa.gov/pub/1dd-v1.2/1dd_v1.2.software .

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It is possible to **read a day of byte-swapped data**. The GPCP data are generated using a Silicon Graphics, Inc. Unix workstation, which uses the "big-endian" IEEE 754-1985 representation of REAL*4 unformatted binary words. To read this data on machines which use the IEEE "little-endian" format such as Intel-based PCs, the user will need to reverse the order of the bytes (i.e., byte-swap the data). The code segment below performs this byte swapping. Note that the code segment below is the same as given above, but with the added feature of swapping the bytes.

The sample FORTRAN software to read a day of byte-swapped data is read_1dd_v1.2_day_swap.f. The sample IDL procedure to read all days in the month file in read_1dd_v1.2_file.pro automatically handles byte swapping. See ftp://meso.gsfc.nasa.gov/pub/1dd-v1.2/1dd_v1.2.software .

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5. Definitions and Defining Algorithms

The **day definition** for this data set is the sum of all images given a nominal time in the specified Universal Coordinated Time (UTC, also known as GMT or Z) day.

Because the IR data are provided at 00, 03, ..., 21 UTC, the data set most closely describes the period starting at 2230 UTC the previous day to 2230 UTC of the day named. The alternative of splitting the 00 UTC images between days was more cumbersome and not clearly better in practice.

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The **IR Tb histogram data set** is produced by the Geostationary Satellite Precipitation Data Centre (GSPDC) of the GPCP under the direction of Pingping Xie, located in the Climate Prediction Center, NOAA National Centers for Environmental Prediction, Washington D.C., USA. Each cooperating geostationary (geo) satellite operator (the Geosynchronous Operational Environmental Satellites, or GOES, United States; the Geosynchronous Meteorological Satellite, or GMS, and then Multifunctional Transportation Satellite, or MTSat, Japan; and the Meteorological Satellite, or Meteosat, European Community) forwards thermal infrared (IR) imagery to GSPDC where they are converted to 24-class histograms of Tb on a 1°x1° lat/lon grid. The global geo-IR are then merged on a global grid.

In parallel, the NOAA-series low-earth-orbit (leo) satellite operator (United States) provides GPI values on a 1°x1° lat/lon grid accumulated to the nearest 3-hrly time.

These data are used as input to 1DD processing.

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The **GPROF fractional occurrence of precipitation** is computed as the ratio of the number of pixels with precipitation to the total number of valid pixels, both accumulated on a 0.5°x0.5° lat/lon grid swath by swath.

The Goddard Profiling Algorithm (GPROF) Version 2004 is based on Kummerow et al. (1996) and Olson et al. (1999). Summarizing, GPROF is a multichannel physical approach for retrieving rainfall and vertical structure information from satellite-based passive microwave observations (here, SSMI and SSMIS). Version 2004 applies a Bayesian inversion method to the observed microwave brightness temperatures using an extensive library of cloud-model-based relations between hydrometeor profiles and microwave brightness temperatures. Each hydrometeor profile is associated with a surface precipitation rate. GPROF includes a procedure that accounts for inhomogeneities of the rainfall within the satellite field of view. Over land and coastal surface areas the algorithm reduces to a scattering-type procedure using only the higher-frequency channels. This loss of information arises from the physics of the emission signal in the lower frequencies when the underlying surface is other than all water.

Because SSMIS observes at 91 GHz, while GPROF2004 expects 85 GHz data, we applied a 91 GHz-based 85 GHz proxy channel developed by Vila et al. (2012).

These data are used as input to 1DD processing.
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The **TOVS precipitation estimate** is produced by the Satellite Research Team under the direction of J. Susskind, located at NASA Goddard Space Flight Center's Earth Sciences Division, Greenbelt MD, USA. Data from the Television Infrared Operational Satellite (TIROS) Operational Vertical Sounder (TOVS) instruments aboard the NOAA series of polar-orbiting platforms are processed to provide a host of meteorological statistics. Susskind and Pfaendtner (1989) and Susskind et al. (1997) describe the TOVS data processing.

The TOVS precipitation estimates infer precipitation from deep, extensive clouds. The technique uses a multiple regression relationship between collocated rain gauge measurements and several TOVS-based parameters that relate to cloud volume: cloud-top pressure, fractional cloud cover, and relative humidity profile. This relationship is allowed to vary seasonally and latitudinally. Furthermore, separate relationships are developed for ocean and land.

The TOVS data are used for the period October 1996 – April 2005 and are provided at the 1º spatial resolution and at the daily temporal resolution. The data covering the span up to February 1999 are based on information from two satellites. For the period March 1999 – April 2005, the TOVS estimates are based on information from one satellite due to changes in satellite data format. In addition, the date span 1-17 February 2004 experienced partial (1^{st} and 17^{th}) or total (2-16) loss of TOVS data, so AIRS data are used for February 2004.

These data are used as input to 1DD processing.
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The **AIRS precipitation product** is produced by the Satellite Research Team under the direction of J. Susskind, located at NASA Goddard Space Flight Center's Earth Sciences Division, Greenbelt MD, USA. Data from the AIRS instrument aboard the Earth Observing System Aqua polar-orbiting satellite are processed to provide a host of meteorological statistics. The processing is similar to the TOVS data processing described earlier.

The AIRS precipitation estimates infer precipitation from deep, extensive clouds. The technique uses a multiple regression relationship between collocated rain gauge measurements and several AIRS-based parameters that relate to cloud volume: cloud-top pressure, fractional cloud cover, and relative humidity profile. This relationship is allowed to vary seasonally and latitudinally. Furthermore, separate relationships are developed for ocean and land.

The AIRS data are used for the period May 2005 - present and are provided at the 1º spatial resolution and at the daily temporal resolution. In addition, the date span 1-17 February 2004 experienced partial (1^{st} and 17^{th}) or total (2-16) loss of TOVS data, so AIRS data are used for February 2004. The AIRS precipitation estimates have been bias-adjusted to the TOVS estimates to minimize the TOVS/AIRS data boundary at April/May 2005. Matched histograms of precipitation were computed between the TOVS and AIRS data for the months January, April, July, and October 2004. These seasonal calibrations are applied accordingly to the corresponding seasonal months of data after April 2005.

These data are used as input to 1DD processing.

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The **GPI precipitation product** is produced by the Geostationary Satellite Precipitation Data Centre of the GPCP under the direction of Pingping Xiee, located in the Climate Prediction Center, NOAA National Centers for Environmental Prediction, Washington D.C., USA. Each cooperating geostationary satellite operator (the Geosynchronous Operational Environmental Satellites, or GOES, United States; the Geosynchronous Meteorological Satellite, or GMS, and then the Multifunctional Transportation Satellite, or MTSat, Japan; and the Meteorological Satellite, or Meteosat, European Community) forwards thermal infrared (IR) imagery to GSPDC. The global IR rainfall estimates are then generated from a merger of these data using the GOES Precipitation Index [GPI]; Arkin and Meisner 1987) technique, which relates cold cloud-top area to rain rate.

The GPI technique is based on the use of geostationary satellite IR observations. Colder IR brightness temperatures are directly related to higher cloud tops, which are loosely related to increased precipitation rates. From data collected during the Global Atmospheric Research Programme (GARP) Atlantic Tropical Experiment (GATE), an empirical relationship between brightness temperature and precipitation rate was developed. For a brightness temperature ≤ 235K, a rain rate of 3 mm/hour is assigned. For a brightness temperature > 235K, a rain rate of 0 mm/hour is assigned. The GPI works best over space and time averages of at least 250 km and 6 hours, respectively, in oceanic regions with deep convection.

For the period 1986 – March 1998 the GPI data are accumulated on a 2.5ºx2.5º lat/lon grid for pentads (5-day periods), preventing an exact computation of the monthly average. We assume that a pentad crossing a month boundary contributes to the statistics in proportion to the fraction of the pentad in the month. For example, given a pentad that starts the last day of the month, 0.2 (one-fifth) of its samples are assigned to the month in question and and 0.8 (four-fifths) of its samples are assigned to the following month.

Starting with October 1996 the GPI data are accumulated on a 1ºx1º lat/lon grid for individual 3-hrly images. In this case monthly totals are computed as the sum of all available hours in the month.

In both data sets gaps in geo-IR are filled with low-earth-orbit IR (leo-IR) data from the NOAA series of polar orbiting meteorological satellites. However, the 2.5ºx2.5º data only contain the leo-IR used for fill-in, while the 1°x1° data contain the full leo-IR. The latter allows a more accurate AGPI (see "AGPI precipitation product"). The Indian Ocean sector routinely lacked geo-IR coverage until Meteosat-5 was repositioned in June 1998.

The Version 2.1 GPI product is based on the 2.5ºx2.5º IR data for the period 1988-1996, and the 1ºx1º beginning in 1997. The boundary is set at January 1997 to avoid making the change during the 1997-1998 ENSO event.

These data are used as input to the GPCP Satellite-Gauge Precipitation Product and the leo-GPI are used as input to the TMPI.
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The **AGPI precipitation product** is produced as part of the GPCP Version 2.2 Combined Precipitation Data Set by the GPCP Merge Development Centre (see section 2). The technique follows the Adjusted GPI (AGPI) of Adler et al. (1994).

During the DMSP period (starting July 1987), separate monthly averages of approximately coincident GPI and merged SSMI(SSMIS)–TOVS(AIRS) precipitation estimates are formed by taking cut-outs of the 3-hourly GPI values that correspond most closely in time to the local overpass time of the DMSP platform. The ratio of merged SSMI(SSMIS)–TOVS(AIRS) to GPI averages is computed and controlled to prevent unstable answers. In regions of light precipitation an additive adjustment is computed as the difference between smoothed merged SSMI(SSMIS)–TOVS(AIRS) and ratio-adjusted GPI values when the merged SSMI(SSMIS)–TOVS(AIRS) is greater, and zero otherwise. The spatially varying arrays of adjustment coefficients are then applied to the full set of GPI estimates. In regions lacking geo-IR data, leo-GPI data are calibrated to the merged SSMI(SSMIS)–TOVS(AIRS), then these calibrated leo-GPI are calibrated to the geo-AGPI. This two-step process tries to mimic the information contained in the AGPI, namely the local bias of the SSMI and possible diurnal cycle biases in the geo-AGPI. The second step can only be done in regions with both geo- and leo-IR data, and then smooth-filled across the leo-IR fill-in. In the case of the 2.5ºx2.5º IR, which lacks leo-IR in geo-IR regions, the missing calibrated leo-GPI is approximated by smoothed merged SSMI(SSMIS)–TOVS(AIRS) for doing the calibration to geo-AGPI.

The period before mid-1987 is handled differently, but is not relevant to the 1DD.

These data are used as input to the GPCP Satellite-Gauge Precipitation Product.
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The GPCP **satellite-gauge precipitation product** (SG) is produced as part of the GPCP Version 2.2 Combined Precipitation Data Set by the GPCP Merge Development Centre (GMDC; Adler et al. 2003, Huffman et al. 2009). The monthly data are delivered on a 2.5ºx2.5º grid.

The combination of satellite data into a multi-satellite (MS) product is carried out differently during 3 periods according to data availability. Strong efforts were made to homogenize the data record:

The period mid-1987 to the present uses geo-IR, low-Earth-orbit (leo)-IR, TOVS, AIRS, SSMI, and SSMIS satellite data enter the SG combination. TOVS(AIRS) is merged in with SSMI(SSMIS) where the SSMI(SSMIS) is suspect (outside about 45ºN-S) or missing. Then SSMI(SSMIS) and geo-IR are approximately time-matched to compute local coefficients to adjust the full geo-IR GPI to the bias of the SSMI(SSMIS) in the 40ºN-S band. As well, leo-IR GPI is approximately scaled to the SSMI(SSMIS). The AGPI is built from geo-IR AGPI where possible and leo-IR AGPI elsewhere. The Multi-Satellite (MS) intermediate product is composed of AGPI in the band 40ºN-S and the merged SSMI(SSMIS)–TOVS(AIRS) elsewhere.

The periods before mid-1987 are handled differently, but are not relevant to the 1DD.

Throughout, the MS and GPCC gauge analysis are linearly combined into a satellite-gauge (SG) combination using weighting by inverse estimated mean-square error for each.

The 1DD values are calibrated to sum to the SG on a monthly basis.
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The Threshold Matched Precipitation Index (**TMPI*) provides GPI-like precipitation estimates in which both the IR Tb threshold and the conditional rain rate for raining pixels are set locally in time and space:

- The geo-IR Tb threshold (Tb0) is set locally from month-long accumulations of time/space coincident geo-IR Tb and GPROF-SSMI(SSMIS)-based fractional occurrence of precipitation. In Version 1.2 the microwave frequency of precipitation is computed with only the 6 a.m./p.m. SSMI and SSMIS satellites to achieve a more CDR-like homogeneity. In previous versions, all available microwave satellites were used, potentially creating a heterogeneous record.
- The conditional rain rate is set locally from the resulting frequency of Tb<Tb0 for the ENTIRE month and the GPCP SG.
- Separately, leo-IR GPI are processed like the TOVS(AIRS) (see "AdSND") because they suffer a similar over-estimate of precipitation frequency.

The available geo-IR histograms in each 3-hrly global image are processed into precipitation estimates, and the adjusted leo-GPI data are used to fill holes in the individual 3-hrly geo-IR images. Then all the available images in a UTC day (00, 03, ..., 21 UTC) are averaged to produce the daily estimate (on a 1ºx1º grid).

These data are produced as intermediate files in 1DD processing.
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The Adjusted Sounding-based precipitation estimates (**AdSND*) are computed with both TOVS and AIRS estimates, and are produced outside 40ºN-S to make the 1DD globally complete. The Susskind et al. (1997) precipitation estimates from TOVS(AIRS) were considered to have too large a number of rain days, and we wanted to maintain consistency with the monthly GPCP SG. Accordingly, we revise the TOVS(AIRS) estimates by:

- computing the ratio of TMPI rain days to TOVS(AIRS) rain days separately for 39-40ºN and 39-40ºS;

- using the corresponding ratio in each grid box over the entire hemisphere to reduce the occurrence of TOVS(AIRS) precipitation by zeroing the (1-ratio) smallest daily TOVS(AIRS) rain accumulations; and
- rescaling the remaining (non-zero) TOVS(AIRS) rain days to sum to the monthly SG.

The daily data are gridded at 1ºx1º. These data are produced as intermediate files in 1DD processing.

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The One-Degree Daily (**1DD**) precipitation data set is a first approach to estimating global daily precipitation at the 1ºx1º scale strictly from observational data. It is composed of TMPI where available (40ºN-S) and AdSND elsewhere. The data boundaries at 40ºN and 40ºS do not exhibit serious problems, probably because both the TMPI and AdSND are responding to <u>cloud</u> features. Nevertheless, smoothing was performed at the data boundaries as follows:

- The [TMPI-AdSND] difference was computed at all grid boxes in the bands 39-40ºN and 39-40ºS.
- The difference field is linearly reduced toward zero for grid boxes poleward of the 40° boundaries at the constant rate of 2 mm/d per degree of latitude using smoothing on a 3x3 gridbox template. [The constant was chosen subjectively to balance smoothing and change in the fractional coverage.] Where the difference is more than ±2 mm/d at 44-45°N and S, the rate of damping is linearly increased along longitude lines to force the value to ±2 mm/d at 45°N and S. This happens rarely and prevents large artifacts that appeared in prior versions.
- The difference field is added to the AdSND field.

The smoothing improves continuity across the data boundary with a slight (local) increase in the fractional occurrence field. This approach is a change from the more intrusive "smoothfill" scheme used in Versions 1 and 1.1.

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The **units of the 1DD estimates** are mm/day.

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6. Temporal and Spatial Coverage And Resolution

The **file date** is the UTC month in which nominal times of the input data occur. Thus, a 00 UTC image is NOT divided between the two days it borders. All dates are UTC.

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The **temporal resolution** of the products is one day. The temporal resolution of the original single-source data sets varies: 3-hrly for geo-IR, 3-hr accumulations for leo-IR, snapshot for GPROF fractional occurrence, monthly for GPCP SG, and daily for TOVS. Some of the single-source data sets are available from other archives at a finer resolution.

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The *period of record* for the GPCP 1DD is October 1996 to the delayed present. The start is based on the availability of 3-hrly IR data. The end is based on the availability of input analyses, and will be extended in future releases. Some of the single-source data sets have longer periods of record in their original archival sites.

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The *grid* on which each field of values is presented is a 1ºx1º latitude–longitude (Cylindrical Equal Distance) global array of points. It is size 360x180, with X (longitude) incrementing most rapidly West to East from the Prime Meridian, and then Y (latitude) incrementing North to South. Whole- and half-degree values are at grid edges:

First point center = (89.5ºN,0.5ºE)
Second point center = (89.5ºN,1.5ºE)
Last point center = (89.5ºS,0.5ºW)

The reference datum is WGS84.

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The *spatial resolution* of the products is 1ºx1º lat/long. Some of the single-source data sets are available from other archives at a finer resolution.

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The *spatial coverage* of the products is global in the sense that they are provided on a global grid. However, a small scattering of points are missing at the poles due to the forward regridding used in TOVS. In the current version these missing values are filled by average-filling the final fields. This step also fills in small areas of missing, particularly near the poles, but they are rare and the filling is considered beneficial. See "processing changes" and "known anomalies" for more discussion of the average-fill issue. Backward gridding is applied to AIRS, so this issue does not exist for February 2004 and after April 2005.

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7. Production and Updates

The GPCP is responsible for managing *production and updates* of the GPCP 1DD Data Set (WCRP 1986). The 1DD is produced by the GPCP Merge Development Centre (GMDC), located at NASA Goddard Space Flight Center in the Mesoscale Atmospheric Processes Laboratory, Greenbelt MD, USA.

Various groups in the international science community are given the tasks of preparing precipitation estimates from individual data sources, then the GMDC is charged with combining these into a "best" global product. This activity takes place after real time, at a pace governed by agreements about forwarding data to the individual centers and activities designed to ensure the quality in each processing step. The techniques used to compute the combined estimates are described in section 5.

Updates will be released to (1) extend the data record, (2) take advantage of improved combination techniques, or (3) correct errors. Updates resulting from the last two cases will be given new version numbers.

NOTE: The changes described in this section are typical of those that are required to keep the GPCP Combined Precipitation Data Set abreast of current requirements and science. Users are strongly encouraged to check back routinely for additional upgrades, and to refer other users to this site rather than redistributing data that are potentially out of date.

At the present the GMDC and the GPCP are making plans to replace the 1DD with a fine-scale (3-hour, 0.25ºx0.25º) product that directly incorporates high-quality microwave estimates into the individual 3-hourly fields. The high-quality estimates will likely include SSMI, SSMIS, TRMM Microwave Imager (TMI), Advanced Microwave Sounding Unit-B (AMSU-B), Microwave Humidity Sounder (MHS), and Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E) estimates (see, e.g., Huffman et al., 2007).
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To date, these **processing changes** have been implemented in the 1DD code:

1. The microwave frequency of precipitation is now computed with only the 6 a.m./p.m. SSMI and SSMIS satellites to achieve a more CDR-like homogeneity. In previous versions, all available microwave satellites were used, potentially creating a heterogeneous record.
2. The algorithm to fill in the gaps in daily TOVS (AIRS) data has been modified from an iterative smooth-fill scheme, which completely fills all gaps, to a boxcar average which preserves large gaps. The new boxcar averaging scheme uses a latitude-based 3x3 grid on which the east-west size of the box approximately matches the north-south size. This change was motivated by large gaps that arose in the TOVS data during the span September 11-18, 2001. Users should be aware that gaps may occur throughout the 1DD data record.
3. The date span 1-17 February 2004 experienced partial (1st and 17th) or total (2-16) loss of TOVS data, so AIRS data are used for February 2004 in Version 2.1 of the SG and in Version 1.2 of the 1DD.

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A number of **known data set issues** exist:

1. In the 1ºx1º 3-hrly GPI it is possible for the two satellites to cut in and out on successive hours in gridboxes nearly equidistant from the pair. As long as the relative contribution of each is evenly distributed over the entire month this is not too important. Using inter-satellite calibrated data would overcome this issue, although it is likely a second-order effect.
2. The TOVS precipitation estimates for the SSMI period July 1987 - February 1999 are based on two satellites. For February 1999 – April 2005, the TOVS estimates are based on only one satellite.
3. TOVS data were partially denied for the period 10-18 September 2001 and cannot be recovered. As well, various operational issues caused partially or completely missing days of TOVS data. In a future reprocessing, partial and completely missing days will be replaced with AIRS data during the overlap period, May 2002 – April 2005.

4. The AIRS precipitation estimates are calibrated to approximately match the zonal average TOVS using the months January, April, July, and October 2004 as the seasonal calibration months, but regional differences remain.
5. Beginning with May 2005, AIRS precipitation estimates have replaced the TOVS estimates at high latitudes because of TOVS instrument termination. The new AIRS data has been adjusted to match the large-scale bias of the TOVS to maintain homogeneity across the data boundary. For simplicity, any distributed dataset that depends on TOVS before May 2005 will utilize AIRS data in place of the TOVS as of that date.
6. The rain gauge data used in the Version 2.2 SG analysis consists of GPCC Full Version 6 for the period 1979-2010 and GPCC Monitoring Version 4 for the period 2011 - present. Though there is strong consistency in analysis scheme, quality control, and data sources between the two analyses, there exists a minimal possibility of a discernible boundary at the cross-over month for the land precipitation.
7. Every attempt has been made to create an observation-only based precipitation data set. However, the TOVS estimates rely on numerical model data to initialize the estimation technique. It is believed that the impact of the numerical model data is minimal on the final precipitation estimates.
8. Some polar-orbiting satellites can experienced significant drifting of the equator-crossing time during their period of service. There is no direct effect on the accuracy of the data, but it is possible that the systematic change in sampling time could introduce biases in the resulting precipitation estimates. This is an issue for the GPCP SG, but not the 1DD directly.

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8. Sensors

The Special Sensor Microwave/Imager (*SSMI*) is a multi-channel passive microwave radiometer that has flown on selected Defense Meteorological Satellite Program (DMSP) platforms since mid-1987. The DMSP is placed in a sun-synchronous polar orbit with a period of about 102 min. The SSMI provides vertical and horizontal polarization values for 19, 22, 37, and 85 GHz frequencies (except only vertical at 22) with conical scanning. Pixels and scans are spaced 25 km apart at the suborbital point, except the 85-GHz channels are collected at 12.5-km spacing. Every other high-frequency pixel is co-located with the low-frequency pixels, starting with the first pixel in the scan and the first scan in a pair of scans. The channels have resolutions that vary from 12.5x15-km for the 85 GHz to 60x75-km for the 19 GHz. Pixels are oval due to the slanted viewing angle.

The polar orbit provides nominal coverage over the latitudes 85ºN-S, although limitations in retrieval techniques prevent useful precipitation estimates in cases of cold land (scattering), land (emission), or sea ice (both scattering and emission).

The SSMI is an operational sensor, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, etc. Over time the coverage has improved as the operational system has matured. Although not relevant here, for completeness we note that the first 85 GHz sensor to fly (on F08) degraded quickly due to inadequate solar shielding. After launch in mid-1987, the 85 GHz vertical- and horizontal-polarization channels became unusable in 1989 and 1990, respectively.

Further details are available in Hollinger et al. (1990).

Unlike previous versions, in Version 1.2 the GPROF fractional occurrence estimates are based on GPROF-SSMI estimates computed for satellites at 6 a.m./p.m. to maintain consistent diurnal bias characteristics:

Satellite	*Record Period*
F13	03 May 1995 – December 2008

....

The Special Sensor Microwave Imager/Sounder (**SSMIS**) is a multi-channel passive microwave radiometer that has flown on selected Defense Meteorological Satellite Program (DMSP) platforms since late 2003. The DMSP is placed in a sun-synchronous polar orbit with a period of about 102 min. The SSMIS provides vertical and horizontal polarization values for the SSMI-like 19, 22, 37, and 91 GHz frequencies (except only vertical at 22) with conical scanning, as well as other channels with a heritage in the Special Sensor Microwave/Temperature 2 (SSMT2) sensor. Unlike SSMI, every SSMIS scan observes at all channels: pixels and scans are spaced 25 and 12.5 km apart at the suborbital point for channels below 91 GHz, 12.5 km for both pixel and scans for 91 GHz. Thus, the high-frequency channels have twice as many footprints per scan as the lower-frequency channels. Separate feed horns are used for 91 GHz and the rest of the SSMI-like frequencies, so there is not a 1:1 co-location of channel values, as there is for SSMI. The SSMI-like channels have the resolutions

46.5x73.6 km (19, 22 GHz)
31.2x45.0 km (37 GHz)
13.2x15.5 km (91 GHz)

with the slanted viewing angle and in-line processing determining the oval shape.

For ocean regions, the group producing the Microwave Emission brightness Temperature Histogram (METH) precipitation estimates uses the RSS V6 SSMI and SSMIS Tb data set to cover the DMSP era. Berg (April 2012, private communication) calibrated all imaging channels for SSMI and SSMIS sensors to those of the F13 SSMI using the FNMOC archive. Specifically, the calibration biases for the F17 SSMIS are 0.25K for the 19V and -0.40 K for the 22V (relative to F13). Given these results, the RSS F17 Tb's for 19V and 22V were provisionally calibrated to the F13 by adding the Berg Tb biases:

Calibrated Tb(F17 19V) = Tb(F17 19V) – 0.25K
Calibrated Tb(F17 22V) = Tb(F17 22V) – 0.40K.

Case A) The METH code was run with these calibrations for the F13-F17 overlap period of January 2008 – September 2009. A spatially fairly uniform bias of -1.72K in T_0 (the fitted mean of $2T_{19V} – T_{22V}$) was noted.

Case B) The T_0 for F17 was adjusted to match that of F13 and the calculations repeated.

Table 1 shows that the second calibration reduces the global biases in three key parameters (T_0, freezing level, and rain rate), while the improvement in RMSD and correlation coefficients is modest.

Table 1. Summary of domain-mean (100% ocean, 60°N-S) parameters for a) Berg inter-satellite calibrated Tb's, and b) case a) with T_0 adjustment. The freezing level and rain rate are denoted by FL and RR, respectively.

		F13 SSM/I	F17 SSMIS	Bias (F13-F17)	RMSD	Corr. coeff.
a)	T0 (K)	171.720	173.445	-1.725	1.950	0.968
	FL (km)	4.275	4.225	0.050	0.188	0.948
	RR (mm/d)	2.845	2.908	-0.063	1.547	0.882
b)	T0 (K)	171.720	171.726	-0.0064	2.911	0.968
	FL (Km)	4.275	4.276	-0.0018	0.185	0.946
	RR (mm/d)	2.845	2.857	-0.0114	1.537	0.882

Over land the SSMIS estimates are computed with a modification of the NESDIS scattering algorithm by D. Vila that accounts for navigation and scan-strategy differences, calibrates the Ta's for all channels to approximate the behavior of coincident SSMI Ta's, and develops 85-GHz proxy channels from the SSMIS 91 GHz channels. The calibration to SSMI first applies "scan correction coefficients" to each of the SSMIS channels, which adjust the Ta value by a scale factor that is very close to 1.0, but which varies by field of view. This has to do with achieving scan uniformity, because the Ta values tend to drop off at the edge of the scan. Second, a histogram match is applied to the Ta's, dependent on surface type, to make the SSMIS values look like SSMI. This is done separately for the 19, 22, 37, and 91 GHz Ta's. Finally, there is a Ta-to-Tb conversion. See Vila et al. (2012) for more details.

The polar orbit provides nominal coverage over the latitudes 85ºN-S, although limitations in current retrieval techniques prevent useful precipitation estimates in cases of cold land (scattering), land (emission), or sea ice (both scattering and emission).

The SSMIS is an operational sensor, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, etc. Over time the coverage has improved as the operational system has matured.

Further details are available in Northrup Grumman (2002).

The SSMIS estimates are based on data from the F17 instrument from January 2009 through the present.

Satellite	*Record Period*
F17	January 2009 – present

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The infrared (*IR*) data are collected from a variety of sensors. The primary source of IR data is the international constellation of geosynchronous-orbit meteorological satellites – the Geosynchronous Operational Environmental Satellites (GOES, United States); the Geosynchronous Meteorological Satellite, and subsequently Multifunctional Transportation Satellite (GMS and MTSat, Japan); and the Meteorological Satellite (Meteosat, European

Community). There are usually two GOES platforms active, GOES-EAST and -WEST, which cover the eastern and western United States, respectively. Gaps in geosynchronous coverage (most notably over the Indian Ocean prior to June 1998) must be filled with IR data from the NOAA-series polar-orbiting meteorological satellites. The geosynchronous data are collected by scanning (parts of) the earth's disk, while the polar-orbit data are collected by cross-track scanning. The data are accumulated for processing from full-resolution (4x8-km) images.

Starting with October 1996 the IR data are accumulated on a 1°x1° lat/lon grid for individual 3-hrly images. In parallel, all low-earth orbit IR (leo-IR) data from the NOAA series of polar orbiting meteorological satellites are accumulated to the nearest 3-hr time on a 1°x1° grid.

The various IR instruments are operational sensors, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, sensor failures, etc.

Further details are available in Janowiak and Arkin (1991).

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The TIROS Operational Vertical Sounder (*TOVS*) dataset of surface and atmospheric parameters are derived from analysis of High-Resolution Infrared Sounder 2 (HIRS2) and Microwave Sounding Unit (MSU) data aboard the NOAA series of polar-orbiting operational meteorological satellites. The retrieved fields include land and ocean surface skin temperature, atmospheric temperature and water vapor profiles, total atmospheric ozone burden, cloud-top pressure and radiatively effective fractional cloud cover, outgoing longwave radiation and longwave cloud radiative forcing, and precipitation estimate.

For the period January 1979 – April 2005 (used October 1996 – April 2005), the TOVS precipitation estimates are accumulated on a 1°x1° lat/lon grid at the daily temporal resolution. Due to the estimation technique and the polar orbit of the NOAA satellites, TOVS provides a globally complete estimate of precipitation. In addition, the date span 1-17 February 2004 experienced partial (1^{st} and 17^{th}) or total (2-16) loss of TOVS data, so AIRS data are used for February 2004.

For the period January 1979 – February 1999 (used October 1996 – February 1999), the TOVS estimates are based on two NOAA satellites orbiting in quadrature. Beginning in March 1999, the TOVS estimates are based on a single NOAA satellite. This occurred as the result of the failure of NOAA-11.

The various instruments contributing to TOVS are operational sensors, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, sensor failures, etc.

Further details are available in Susskind et al (1997).

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The Atmospheric Infrared Sounder (*AIRS*) dataset of surface and atmospheric parameters are derived from analysis of High-Resolution Infrared Sounder data aboard the Earth Observing System Aqua polar-orbiting satellite. The retrieved fields include land and ocean surface skin temperature, atmospheric temperature and water vapor profiles, total atmospheric ozone burden, cloud-top pressure and radiatively effective fractional cloud cover, outgoing longwave radiation and longwave cloud radiative forcing, and precipitation estimate.

For the period April 2005 – present, the AIRS precipitation estimates are accumulated on a 1ºx1º lat/lon grid at the daily temporal resolution. In addition, the date span 1-17 February 2004 experienced partial (1^{st} and 17^{th}) or total (2-16) loss of TOVS data, so AIRS data are used for February 2004. Due to the estimation technique and the polar orbit of the Aqua satellite, AIRS provides a globally complete estimate of precipitation.

The various instruments are operational sensors, so the data record suffers the usual gaps in the record due to processing errors, down time on receivers, sensor failures, etc.
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9. Error Detection and Correction

SSMI(SSMIS) error detection/correction has several parts. Built-in hot- and cold-load calibration checks are used to convert counts to antenna temperature (Ta). An algorithm has been developed to convert Ta to brightness temperature (Tb) for the various channels (eliminating cross-channel leakage). As well, systematic navigation corrections are performed. All pixels with non-physical Tb and local calibration errors are deleted.

Accuracies in the Tb's are within the uncertainties of the precipitation estimation techniques. For the most part, tests show only small differences among the SSMI(SSMIS) sensors flying on different platforms.

Some satellites experienced significant drifting of the Equator-crossing time during their period of service. There is no direct effect on the accuracy of the SSMI(SSMIS) data, but it is possible that the systematic change in sampling time could introduce biases in the resulting precipitation estimates.
....

The dominant **IR data correction** is for slanted paths through the atmosphere. Referred to as "limb darkening correction" in polar-orbit data, or "zenith-angle correction" (Joyce et al. 2001) in geosynchronous-orbit data, this correction accounts for the fact that a slanted path through the atmosphere increases the chances that (cold) cloud sides will be viewed, rather than (warm) surface, and raises the altitude dominating the atmospheric emission signal (almost always lowering the equivalent Tb). In addition, the various sensors have a variety of sensitivities to the IR spectrum, usually including the 10-11 micron band. Inter-satellite calibration differences are documented, but they are not implemented in the current version. They are planned for a future release. The TMPI largely corrects inter-satellite calibration, except for small effects at boundaries between satellites. The satellite operators are responsible for detecting and eliminating navigation and telemetry errors.
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The *TOVS data correction* mostly depends on the retrieval system generating self-consistent sets of parameters. The requirement for consistency is intended to limit the effect of calibration drift and other faults in the data.

....

The *AIRS data correction* mostly depends on the retrieval system generating self-consistent sets of parameters. The requirement for consistency is intended to limit the effect of calibration drift and other faults in the data.

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There is no *SG error correction* per se. The procedure is designed to minimize bias and throw out outliers, but no post-processing is done. An estimate of RMS random error is attached to each field.

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Three types of *known errors* are contained in part or all of the current data set, and will be corrected in a future general re-run. They have been uncovered by visual inspection, but are considered too minor or insufficiently understood to provoke an immediate reprocessing:

1. The 270K maximum Tb bin limit is too cold in the subtropical highs.
2. Smoothing at the 40ºN and S data boundaries only partially adjusts discontinuities in the individual maps. Also, it introduces small changes in the fractional coverage and amount of precipitation, although the scheme used in Version 1.2 is less intrusive than that used in prior versions.

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Some *known anomalies* in the data set are documented and left intact at the discretion of the data producers:

1. One anomaly occurs due to a change in the treatment of gaps in the TOVS data. Prior to the September 2001 data, the gaps in the TOVS were filled by an iterative smooth-fill algorithm. These gaps tended to be small and a smooth-fill scheme produced realistic precipitation estimates. During the span September 11-18, 2001, large gaps appeared as a result of a known satellite attitude problem. The smooth-fill algorithm was replaced with a latitude-dependent boxcar average scheme which filled smaller gaps but maintained the larger gaps. These gaps are preserved in the final 1DD product.
2. Beginning May 2005, AIRS precipitation estimates are used due to termination of the TOVS satellite. In addition, the date span 1-17 February 2004 experienced partial (1st and 17th) or total (2-16) loss of TOVS data, so AIRS data are used for February 2004. To minimize the inherent data boundary resulting from a change in data source, seasonal TOVS/AIRS climatological corrections have been computed and are routinely applied to the daily AIRS estimates before processing. The goal is to minimize the April/May 2005 data boundary by adjusting the AIRS estimates to the large-scale bias of the TOVS estimates. Since the adjustments are seasonal, daily adjusted AIRS fields will not exactly duplicate the daily fluctuations of the TOVS estimates.

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10. Missing Value Estimation and Codes

There is generally no effort to **estimate missing values** in the single-source data sets.
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All products in the GPCP 1DD Data Set use the **standard missing value** '-99999.'
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All **missing days** are filled entirely with the standard missing value, so that the day number and the position of the day in the file always agree, and there are always complete sequences of day files for the month.
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11. Quality and Confidence Estimates

The **accuracy** of the precipitation products can be broken into systematic departures from the true answer (bias) and transient fluctuations about the true answer (random error), as discussed in Huffman (1997). The former are the biggest problem for climatological averages, since they will not average out. However, on the daily time scale the low number of samples and/or algorithmic inaccuracies tend to present a more serious problem. That is, for leo-IR and TOVS (AIRS) the sampling is spotty enough that the collection of values over one day may not be representative of the true distribution of precipitation over the day. This issue of lower sampling in the leo-IR is most apparent around the Indian Ocean before MeteoSat 5 began operations in July 1998, while for TOVS/AIRS the issue is most visible along 40°N and 40°S. In both cases, these are regions where the sparser data border 8-times-daily TMPI estimates. For geo-IR, leo-IR, and TOVS (AIRS) the algorithms themselves also likely have substantial RMS error.

Accordingly, the "random error" is assumed to be dominant, and estimates could be computed as discussed in Huffman (1997). Random error cannot be corrected.

The "bias error" should average to that of the GPCP SG for the month, and we assume the latter is small, or at least contained. This is particularly true over land, where the SG is adjusted to the large-area bias of the rain gauges. Studies of the submonthly bias have not yet been carried out. Note that regions suffering Tb threshold saturation (mostly subtropical highs) will likely suffer a low bias in order to keep the conditional precipitation rate reasonable. However, totals should be modest, so this is considered tolerable.

For the period January 1979 - February 1999, the TOVS precipitation estimates are based on at least two NOAA satellites flying in quadrature. Beyond February 1999, the TOVS and AIRS estimates are based on single satellites, NOAA-14 and Aqua, respectively. The quantitative impact of using a single NOAA satellite for the TOVS Precipitation estimates on the 1DD product is currently unknown, but certainly leads to additional random error. Qualitatively, the single-satellite sampling leads to salt-and-pepper missings in TOVS over the globe, due to forward regridding. Such missings are precluded in the AIRS data by employing a backward gridding scheme.

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The 1DD *intercomparison results* are still being developed. The time series of the global images shows good continuity in time and spatially across the data boundaries. An early validation of the original 1DD against the Oklahoma Mesonet by the Surface Reference Data Center appears to show underestimation during the spring and fall (by about 20 and 15%, respectively), and overestimation during the summer (by about 20%). Mean absolute error (correlation) peaks (is minimum) in summer and is a minimum (peaks) in winter. An independent study of large-area averages over the Baltic drainage basin show reasonable behavior in all seasons for the original 1DD (Rubel and Rudolph 1999). Analysis against dense gauge data in Finland also shows reasonable behavior for the original 1DD, with better results in the summer than the winter (Bolvin et al. 2009). Overall, the original 1DD appears to have worked as expected in both the TMPI and TOVS(AIRS) data, and this should continue to be true in Version 1.2.

Huffman et al. (2001) contains additional statistics for the original 1DD.
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12. Data Archives

The *archive and distribution sites* for the official release of the GPCP 1DD Precipitation Data Set are:

Mr. David Smith
World Data Center A (WDC-A)
National Climatic Data Center (NCDC)
Rm 120
151 Patton Ave.
Asheville, NC 28801-5001 USA
Phone: 828-271-4053
Fax: 828-271-4328
Internet: *david.p.smith@noaa.gov*
WDC-A Home Page: *http://lwf.ncdc.noaa.gov/oa/wmo/wdcamet-ncdc.html*

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Internet: *david.t.bolvin@nasa.gov*
MAPL Precipitation Page: *http://precip.gsfc.nasa.gov*

Independent archive and distribution sites exist for the single-source data sets, and a current list may be obtained by contacting Dr. Huffman.
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13. Documentation

The **documentation creator** is:

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The **documentation revision history** is:

November 12, 1999	Draft 1 by GJH	March 3, 2003	Rev.29 by DTB
January 11, 2000	Rev.1 by DTB	July 28, 2003	Rev.30 by DTB
March 14, 2000	Rev.2 by DTB	January 14, 2004	Rev.31 by DTB
October 4, 2000	Rev.3 by GJH	January 27, 2004	Rev.32 by DTB
March 1, 2001	Rev.4 by DTB	February 3, 2004	Rev.33 by DTB
March 28, 2001	Rev.5 by DTB	February 20, 2004	Rev.34 by DTB
April 19, 2001	Rev.6 by DTB	February 25, 2004	Rev.35 by DTB
June 4, 2001	Rev.7 by DTB	March 15, 2004	Rev.36 by DTB
June 28, 2001	Rev.8 by DTB	April 21, 2004	Rev.37 by DTB
August 1, 2001	Rev.9 by DTB	July 14, 2004	Rev.38 by DTB
August 18, 2001	Rev.10 by DTB	July 16, 2004	Rev.39 by DTB
September 4, 2001	Rev.11 by DTB	August 2, 2004	Rev.40 by DTB
October 17, 2001	Rev.12 by DTB	October 27, 2004	Rev.41 by DTB
November 2, 2001	Rev.13 by DTB	November 4, 2004	Rev.42 by DTB
February 2, 2002	Rev.14 by DTB	November 19, 2004	Rev.43 by DTB
February 5, 2002	Rev.15 by DTB	December 13, 2004	Rev.44 by DTB
February 14, 2002	Rev.16 by GJH/DTB	January 11, 2005	Rev.45 by DTB
March 29, 2002	Rev.17 by DTB	January 21, 2005	Rev.46 by DTB
April 4, 2002	Rev.18 by DTB	February 18, 2005	Rev.47 by DTB
May 22, 2002	Rev.19 by DTB	March 22, 2005	Rev.48 by DTB
July 3, 2002	Rev.20 by GJH	April 13, 2005	Rev.49 by DTB
July 16, 2002	Rev.21 by DTB	April 25, 2005	Rev.50 by DTB
July 31, 2002	Rev.22 by DTB	June 6, 2005	Rev.51 by DTB
August 26, 2002	Rev.23 by DTB	June 22, 2005	Rev.52 by DTB
September 3, 2002	Rev.24 by DTB	April 14, 2006	Rev.53 by DTB
September 10, 2002	Rev.25 by DTB	April 24, 2006	Rev.54 by DTB
September 26, 2002	Rev.26 by DTB	June 1, 2006	Rev.55 by GJH/DTB
October 31, 2002	Rev.27 by DTB	June 14, 2006	Rev.56 by DTB
January 10, 2003	Rev.28 by DTB	June 28, 2006	Rev.57 by DTB

August 14, 2006	Rev.58 by DTB	August 24, 2007	Rev.71 by DTB
September 9, 2006	Rev.59 by DTB	October 10, 2007	Rev.72 by DTB
September 26, 2006	Rev.60 by DTB	October 26, 2007	Rev.73 by DTB
October 26, 2006	Rev.61 by DTB	October 31, 2007	Rev.74 by GJH/DTB convert to MSWord source for PDF
December 14, 2006	Rev.62 by DTB		
January 10, 2007	Rev.63 by DTB		
January 22, 2007	Rev.64 by DTB	February 26, 2008	Rev.75 by GJH
February 16, 2007	Rev.65 by DTB	April 9, 2008	Rev.76 by GJH
March 20, 2007	Rev.66 by DTB	July 6, 2009	Rev.77 by GJH Version 1.1
April 26, 2007	Rev.67 by DTB		
May 16, 2007	Rev.68 by DTB	September 18, 2012	Rev.78 by GJH Version 1.2
June 28, 2007	Rev.69 by DTB		
August 6, 2007	Rev.70 by DTB	February 19, 2013	Rev.79 by GJH

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A *citation list* that details refereed papers citing the GPCP is maintained on-line at ftp://precip.gsfc.nasa.gov/pub/gpcp-v2.2/doc/gpcp_citation_list.pdf .

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Acronyms:

1DD	One Degree Daily
AdSND	Adjusted sounding-based estimates (from TOVS and AIRS)
AGPI	Adjusted GPI
AIRS	Atmospheric Infrared Sounder
CPC	Climate Prediction Center
DMSP	Defense Meteorological Satellite Program
GARP	Global Atmospheric Research Programme
GATE	GARP Atlantic Tropical Experiment
Geo	Geosynchronous
GEWEX	Global Energy and Water Cycle Experiment
GMDC	GPCP Merge Development Centre
GMS	Geosynchronous Meteorological Satellite
GOES	Geosynchronous Operational Environmental Satellites
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GPI	Global Precipitation Index
GPROF	Goddard Profiling Algorithm

GSPDC	Geostationary Satellite Precipitation Data Centre
HIRS2	High-Resolution Infrared Sounder 2
IR	Infrared
lat/lon	latitude/longitude
Leo	Low-Earth-orbit
MB	megabytes
MSU	Microwave Sounding Unit
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
SRDC	Surface Reference Data Center
SSMI	Special Sensor Microwave/Imager
SSMIS	Special Sensor Microwave Imager/Sounder
SSU	Stratospheric Sounding Unit
Ta	Antenna Temperature
Tb	Brightness Temperature
TIROS	Television Infrared Operational Satellite
TMPI	Threshold Matched Precipitation Index
TOVS	TIROS Operational Vertical Sounder
UTC	Universal Coordinated Time (same as GMT, Z)
WCRP	World Climate Research Programme
WMO	World Meteorological Organization

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14. Inventories

The **data set inventory** may be obtained by accessing the home pages or contacting the representatives listed in section 12.

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15. How to Order Data and Obtain Information about the Data

Users interested in **obtaining data** should access the home pages or contact the representatives listed in section 12.

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The **data access policy** is "freely available" with three common-sense caveats:

1. The data set source should be acknowledged when the data are used. The International Polar Year (IPY) Data policy guidelines (http://ipydis.org/data/citations.html) suggest a formal reference of the form

   Huffman, G.J., D.T. Bolvin, R.F. Adler, 2012, last updated 2012: *GPCP Version 1.2 1-Degree Daily (1DD) Precipitation Data Set*. WDC-A, NCDC, Asheville, NC. Data set accessed <date> at http://www.ncdc.noaa.gov/oa/wmo/wdcamet-ncdc.html.

As an “Acknowledgment”, one possible wording is: "The 1DD data were provided by the NASA/Goddard Space Flight Center's Mesoscale Atmospheric Processes Laboratory, which develops and computes the 1DD as a contribution to the GEWEX Global Precipitation Climatology Project."

2. New users should obtain their own current, clean copy, rather than taking a version from a third party that might be damaged or out of date.
3. Errors and difficulties in the data set should be reported to the data set creators.
4. The GPCP datasets are developed and maintained with international cooperation and are used by the worldwide scientific community. To better understand the evolving requirements across the GPCP user community and to increase the utility of the GPCP product suite, the dataset producers request that a citation be provided for each publication that uses the GPCP products. Please email the citation to *george.j.huffman@nasa.gov* or *david.t.bolvin@nasa.gov*. Your help and cooperation will provide valuable information for making future enhancements to the GPCP product suite.

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