GPCC Annual Report for year 2007

Development of the GPCC Data Base and Analysis Products

Summary

Data Base

During the year 2007 the GPCC observational climate data base has been further complemented with regard to spatial as well as temporal coverage. Monthly precipitation data from 39 WMO member countries have been received and processed into the GPCC Data Base. The GPCC highly appreciates the assistance by all the countries having supplied observed precipitation data. GPCC has now the largest global monthly precipitation station database of the world (data from about 70 000 different stations in more than 170 countries of the world). The complete database has been intensively semi-automatically quality controlled during the second half of year 2007 and the first quarter of 2008.

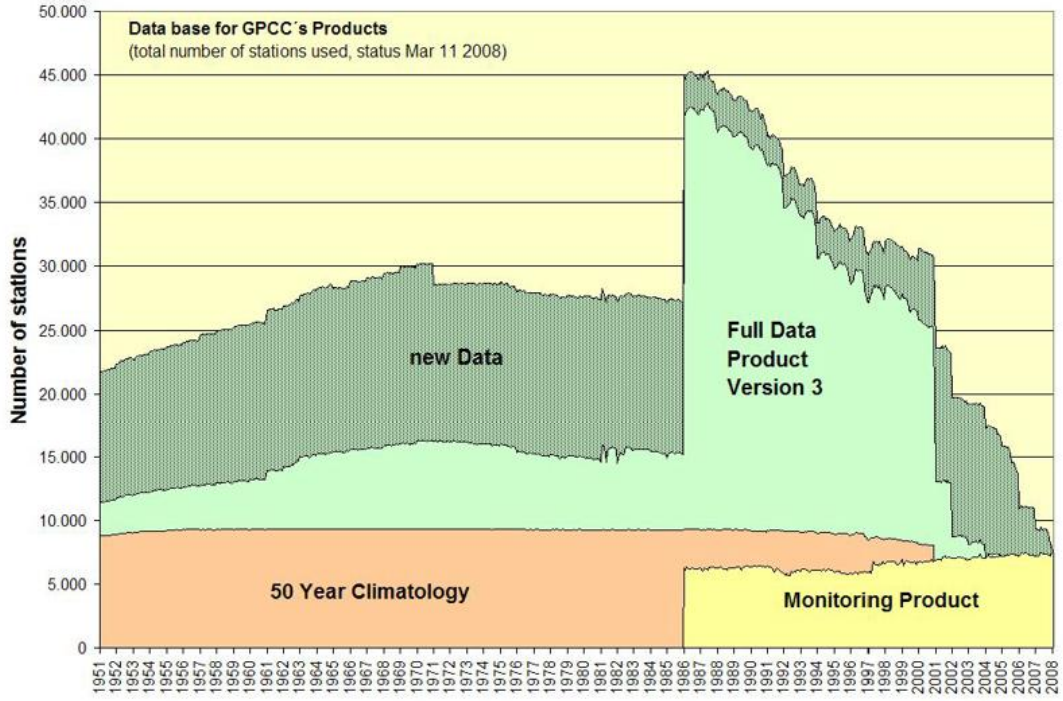
Monthly precipitation totals are routinely accumulated from SYNOP reports received via GTS at DWD and NOAA and obtained from CLIMAT reports received at DWD, JMA and UKMO from a total number of about 7.500 stations. These GTS data have been used as basis for the GPCC near-realtime analyses in year 2007.

Analysis Products

As before, the GPCC continuously processed in year 2007 its two near-realtime analysis products, the First Guess of the monthly global land-surface precipitation anomalies (available within 5 days after the end of the month, based on the globally disseminated synoptic weather reports SYNOP) and the traditional Monitoring Product (available about 2 months after the end of the month, based on the global synoptic reports and, in addition to that, the globally disseminated climate bulletins CLIMAT). Both products are early available but can be affected by typical real-time data deficiencies (sparse coverage, missing data, coding errors). The GPCC First Guess is used in the framework of drought monitoring by FAO and others. The GPCC Monitoring Product is requested by GEWEX/GPCP and is used as an early *in situ* reference for adjustment of satellite-based global precipitation estimates (e.g. Adler et al. 2003, Huffman et al. 1995, Xie and Arkin 1997). The satellite-gauge combined analyses of the GPCP cover the full globe (ocean and land surface) and are of use in many applications as global energy and water cycle studies, verification of global climate models, development of seasonal forecast systems.

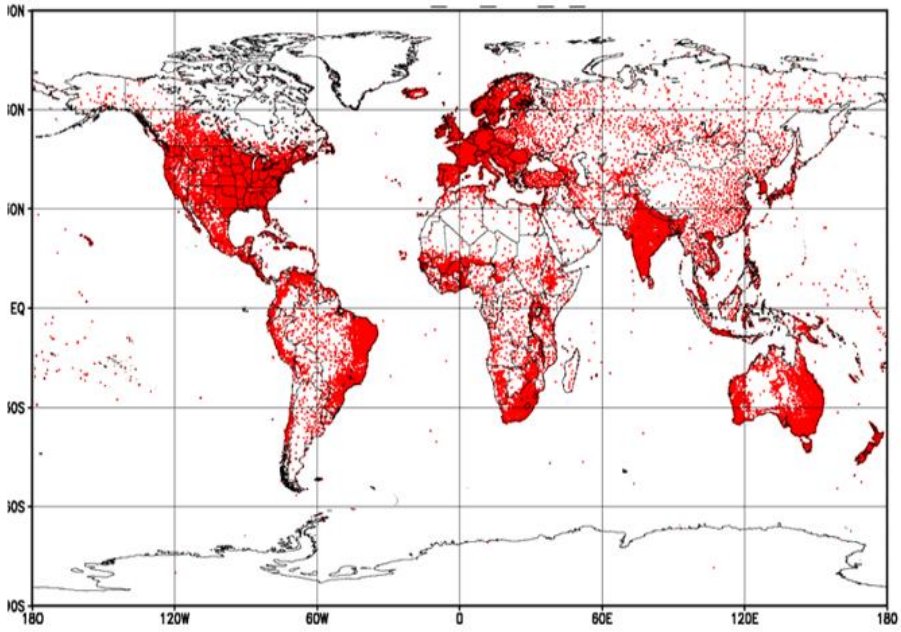
The 2 non-realtime products, GPCC Full Data Reanalysis and GPCC VASClimO, have not been changed during 2007. The current product versions are: GPCC Full Data Version 3, available for the period 1951-2004, and GPCC VASClimO Version 1.1, available for the period 1951-2000. While the Full Data Reanalysis Product provides the best spatial data coverage for each individual month, the VASClimO Climatology is optimized for completeness and homogeneity for the period 1951-2000. Application of the Full Data product is recommended for water budget studies, but the VASClimO Climatology should be preferred for analysis of temporal climate variability, in particular of the spatial distribution of climate change with respect to precipitation. GPCC VASClimO and GPCC Full Data have been input to the IPCC 4AR WG I report published in 2007.

The original station data cannot be redistributed by the GPCC respecting the restrictions of the data owners. But the gridded GPCC products are freely accessible in the Internet for visualisation and download (http://gpcc.dwd.de). All global analysis products mentioned above are available as gridded area averaged data in geographical coordinates (grid box resolutions 0.5° latitude by 0.5° longitude and aggregated to 1.0° x 1.0° and 2.5° x 2.5° boxes).



The figure above shows the composition (number of stations) of the global precipitation station data base of GPCC used for the near real-time "Monitoring product", for the "Full Data Product Version 3" (disseminated Feb. 2005) and for the VASClimO "50-Year Climatology" Version 1.1 (released in August 2005), as well as the "new Data" received and pre-processed in the course of the years 2005-2007.

The significant enlargement of GPCC's monthly precipitation data base during the last years enabled the GPCC to produce a new mean precipitation climatology (reference periods preferably 1951-2000 and 1961-1990) based on climatological normals from about 50 000 stations (which is a doubling in the number of available stations compared to the previous climatology). The new climatology is available in 4 different spatial resolutions: 0.25°, 0.5°, 1.0° and 2.5°.



The figure shows the spatial distribution of the more than 50 000 stations available for calculation of the new GPCC precipitation climatology

GPCC user advices:

- Users of raingauge-based precipitation products should carefully consider, which GPCC product they use for which application (there is no all purpose product);
- Users should carefully take into account the number of stations used for calculation of grid values when interpreting GPCC products (Increase in analysis product grid resolution leads to decrease of the number of available stations per analysis grid leading to increase of the grid sampling error of analysis products);
- Correction factors reg. systematic gauge measuring errors might be applied to the GPCC precipitation products before using them for water balance studies.

GPCC plans for 2008:

- **Continuous enlargement of the GPCC database esp. concerning the period before 1986. Already during the first quarter of 2008 some major data sets have been received e.g. from Iran, USA, Bulgaria, Bhutan, Chile, Botswana, Mozambique.** These as well as additional datasets received in course of year 2008 will be integrated in the GPCC database;
- **Change of the GPCC analysis method from analysing total precipitation amounts to the analysis of relative anomalies using the new precipitation climatology as background.** The quasi-operational products of GPCC (First Guess, Monitoring Product) as well as the non-realtime products (Full Data Reanalysis, VASClimO 50-Year Climatology) are expected to be further improved due to that analysis change, e.g. concerning a better representation of orographic rainfall effects;
- **Production of new versions of the GPCC monthly non-realtime precipitation analysis products** (Spatial resolution of both analysis products will be: 0.5°, 1.0°, 2.5°):
  - **Full Data Reanalysis Version 4 (Analysis period: 1901-2007, planned to be ready by May 2008) and**
  - **VASClimO Climatology Version 2 (Analysis period: 1951-2005, planned to be ready until end of year 2008);**
- **Update and enlargement of the functionalities of the "GPCC Visualiser";**
- **Contribution to a Re-Analysis of the monthly gauge-satellite combined products of the WCRP GEWEX Global Precipitation Climatology Project (GPCP).**

Additional Information

1) Development of the GPCC monthly precipitation data base

a) Near real-time GTS Data Base

Monthly precipitation totals were routinely obtained from SYNOP and CLIMAT reports received via GTS at DWD from a total number of about 7.500 stations. These GTS data have been reformatted and loaded into GPCC's relational data base management system (RDBMS) and they were subsequently used for the monthly near-realtime GPCC Monitoring analyses.

b) GPCC Full Data Base

During year 2007 GPCC received additional monthly precipitation data from 39 countries.

Table 1: Data deliveries of individual countries to GPCC during year 2007

Country	Number of Stations	Period with data YYYY/MM-YYYY/MM
Albania	15	1951/01-1985/12
		2005/01-2006/12
Angola	14	1901/01-2006/12
Bahamas	12	1971/01-2000/12
Belgium	27	2006/01-2006/12
Benin	76	1951/01-2005/12
Bosnia-Herzegovina	50	1892/01-1985/12
Caribbean	13	1968/01-2004/12
China	245	2001/01-2006/12
Colombia	1.500	2000/01-2005/12
Cyprus	9	1925/01-1985/12
		2005/01-2007/09
Czech Republic	70	2006/01-2006/12
Denmark	14	2006/12-2007/11
Egypt	28	2006/01-2006/12
France	950	2006/01-2006/12
Georgia	79	1936/01-2006/12
Guyana	110-140	1882/01-2006/12
Iceland	86	1961/01-2006/12
Iraq	56	1887/01-1958/12
Italy	33	2006/12-2007/11
Jordan	15	1976/01-2005/12
Latvia	20	2006/01-2006/12
Luxembourg	49	1947/01-2006/12
Malaysia	37	2005/01-2006/12
Malta	1	1922/01-2007/11
Mozambique	20	1951/01-1990/12
Nepal	235	1971/01-1984/12
Netherlands	96	2006/11-2007/10
Peru	79	1931/01-2006/12
Poland	140	2006/01-2006/12
Portugal	113	1951/01-2006/12
Slovakia	45	2006/01-2006/12
Switzerland	440	2004/01-2006/12
Tanzania	88	1961/01-2006/12
Thailand	84	2006/01-2006/12

Country	Number of Stations	Period with data YYYY/MM-YYYY/MM
Uganda	19	1982/01-2006/12
United Kingdom	434	2006/01-2006/12
Venezuela	37	1911/01-2005/12
Yemen	12	1985/01-2005/12
Zambia	40	1933/01-2006/12

Please note: GPCC is not able to distribute station-related observational data to others in order to respect the interests of the data suppliers.

Processing of the additionally delivered national/regional data sets (inl. quality control of metadata and observation data) and inserting them into GPCC's RDBMS is a continuous GPCC activity. Fig. 1 displays the temporal evolution of the number of monthly precipitation station data in the GPCC data base from the different sources during the time period 1840-2007 ("SYNOP": GTS-based synoptic weather observations analysed at DWD; „CLIMAT": GTS-based CLIMAT data; „CPC": GTS-based synoptic weather observations analysed at NOAA/CPC; „REG": Regional data bases; „NAT": National data provided by WMO members; „CRU": Database of the Climate Research Unit of University of East Anglia, UK; „GHCN": Database of the Global Historical Climatology Network, USA; „FAO": Database of the UN Food and Agricultural Organisation, Italy; „ALL": Total number of station data from all available sources).

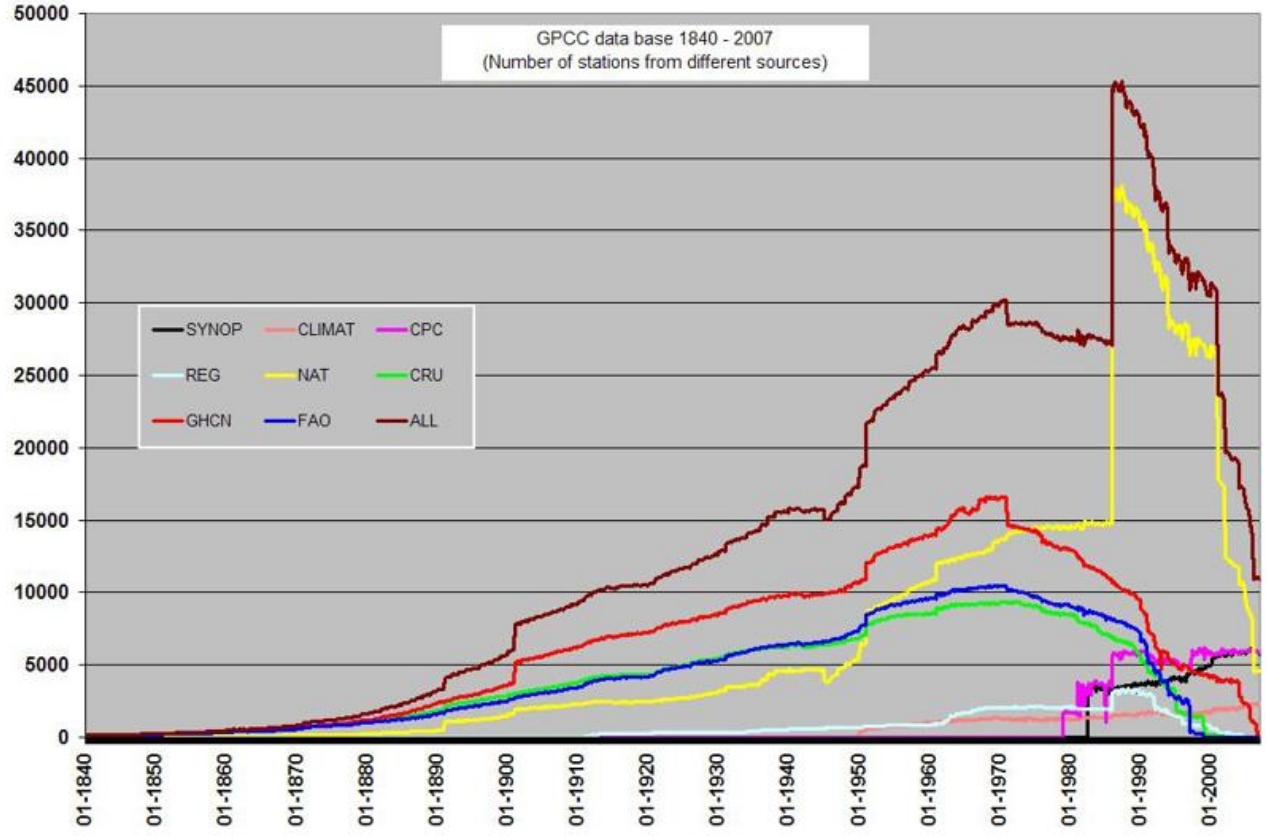


***Fig. 1**: Number of monthly precipitation data in the GPCC data base as a function of time for the different GPCC data sources (for explanation of the data sources see para above)*

Fig. 2a shows the evolution of the GPCC Monthly Precipitation Database (data period from 1951 onwards) between January 2000 and December 2007. It can be seen, that the starting period of GPCC, 1986-2001, is still the period with the highest number of station data. However a larger increase of the number of stations available for the period before 1986 and after 2001 is visible for the last few years when compared to the number of stations for 1986-2001.

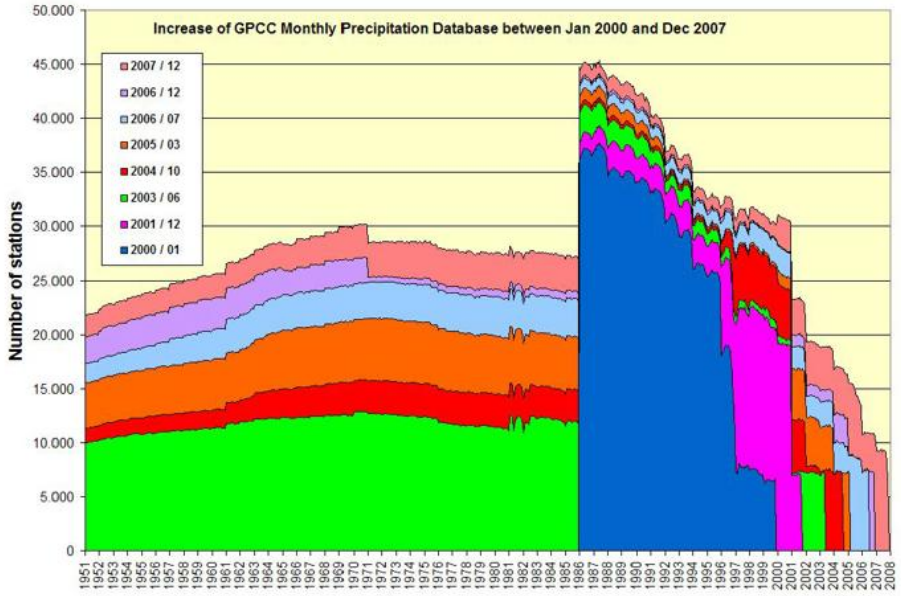


Fig. 2a *Evolution of the GPCC Monthly Precipitation Database between January 2000 and December 2007 (Number of stations per data year)*

Fig. 2b shows the evolution of the number of station months in the GPCC Monthly Precipitation Database (data period from 1951 onwards) during the period December 1997 until December 2007. It indicates, that the extension of the GPCC data base concerning historical data (data before year 1986) started in 2003. The historical extension of the GPCC data base during the last 5 years is very visible by looking at the decades with data before year 1981. Alltogether the number of station months almost increased by a factor of 5 during the last 10 years.

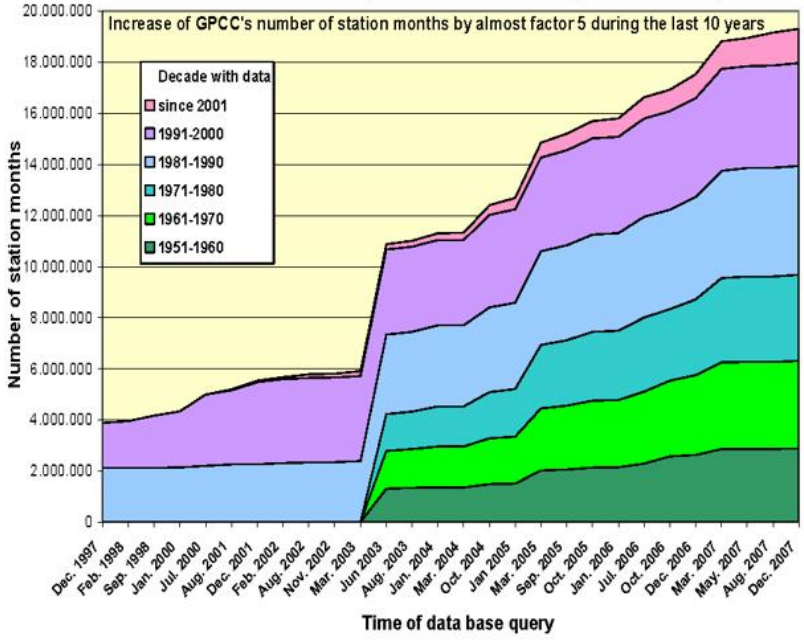


Fig. 2b *Evolution of the GPCC Monthly Precipitation Database between December 1997 and December 2007 (Number of station months per date of data base query)*

The figures 3 a-f indicate the temporal evolution of the spatial coverage of the GPCC database (indicated by the number of stations available for analyses in each 2.5° x 2.5° grid) to be used for GPCC Full Data Reanalysis Version 4. Green and blue colours indicate grids with a sampling error of less than 10 % of the precipitation total on the grid.

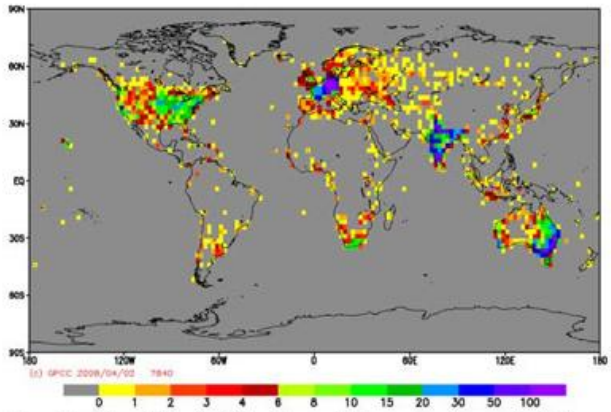


Fig. 3a *Spatial distribution of the number of stations to be used for the new GPCC Full Data Reanalysis Version 4 analysis with 2.5° x 2.5° grid resolution Month: July 1901, Total number of stations: 7840*

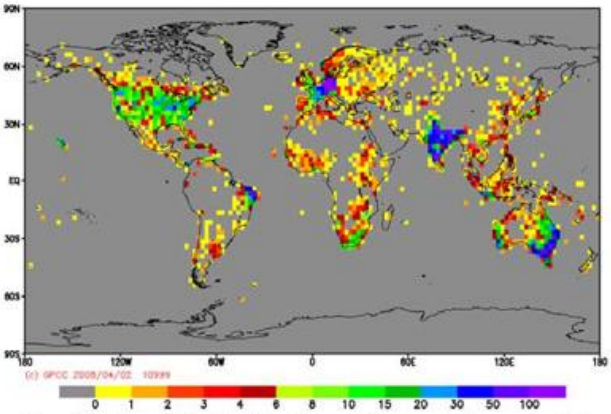


Fig. 3b *Spatial distribution of the number of stations to be used for the new GPCC Full Data Reanalysis Version 4 analysis with 2.5° x 2.5° grid resolution Month: July 1921, Total number of stations: 10999*

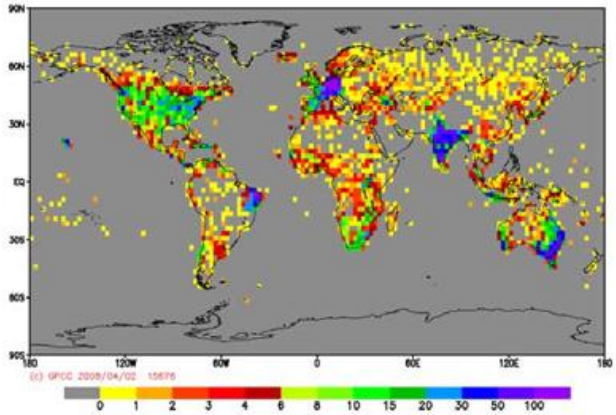


Fig. 3c *Spatial distribution of the number of stations to be used for the new GPCC Full Data Reanalysis Version 4 analysis with 2.5° x 2.5° grid resolution Month: July 1941, Total number of stations: 15676*

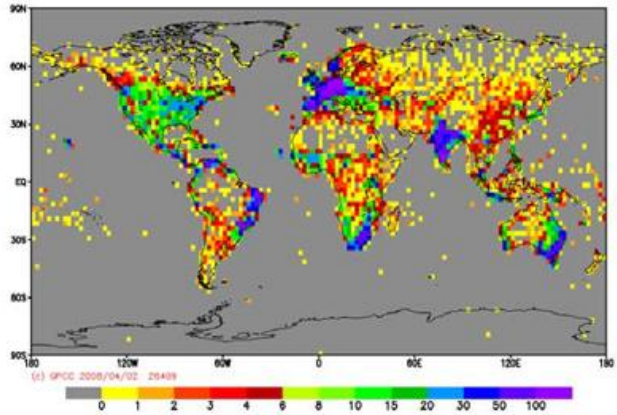


Fig. 3d *Spatial distribution of the number of stations to be used for the new GPCC Full Data Reanalysis Version 4 analysis with 2.5° x 2.5° grid resolution Month: July 1961, Total number of stations: 26409*

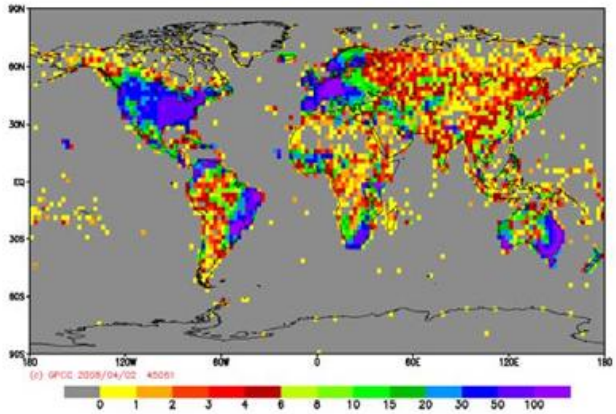


Fig. 3e *Spatial distribution of the number of stations to be used for the new GPCC Full Data Reanalysis Version 4 analysis with 2.5° x 2.5° grid resolution Month: July 1986, Total number of stations: 45061*

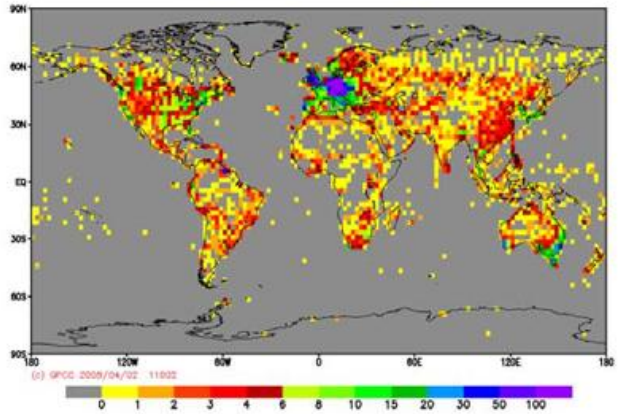


Fig. 3f *Spatial distribution of the number of stations to be used for the new GPCC Full Data Reanalysis Version 4 analysis with 2.5° x 2.5° grid resolution Month: July 2006, Total number of stations: 11002*

2) GPCC Analysis Products

a) GPCC Monitoring Product

The monthly "GPCC Monitoring Product" is now available for all months since January 1986, i.e. 264 months. The GTS-based rain-gauge data used for the GPCC Monitoring Product analyses have been processed and analysed for all months of year 2007. All data were quality-controlled on a high level with automatic plus visual checks. The quality-control results for the year 2007 are summarized in Fig. 4. 6 - 10 % of the totally available stations (500-700 stations every month) are flagged by the automatic GPCC procedures for visual control. Most of the flagged station data can be accepted or modified during manual control. About 2 - 4 % of the available GTS station data need to be rejected. A significant error source is the increasing automatisation of networks (e.g. many rejected stations are AWS in North America continuously reporting 0 mm precipitation).

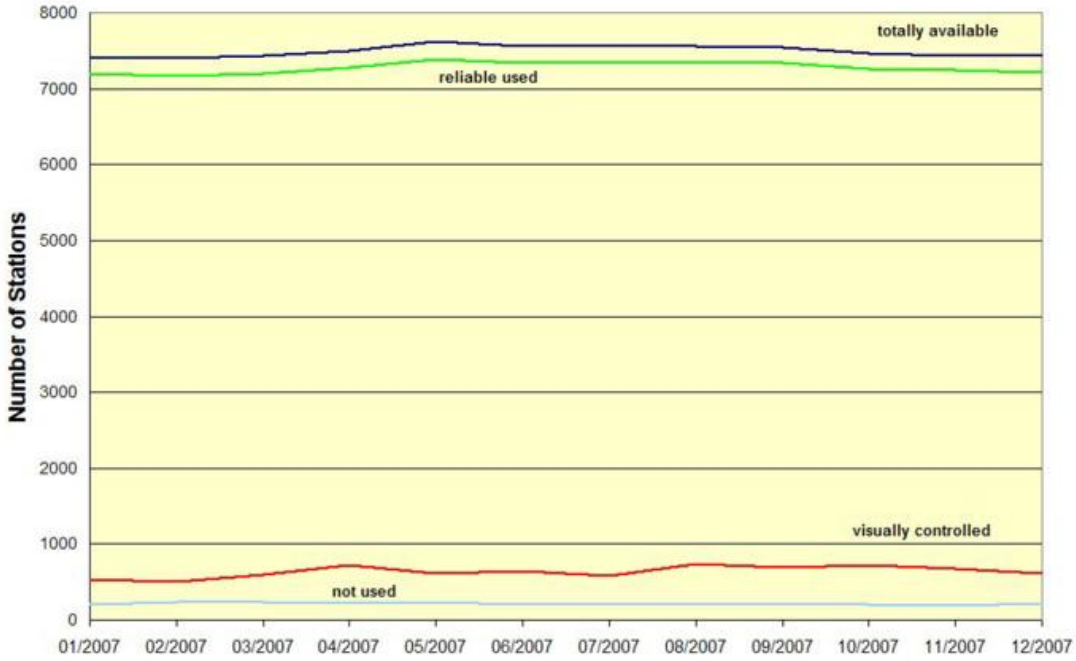


Fig. 4 Quality-control results of data used for GPCC Monitoring product analyses during year 2007

Users of gridded GPCC products are advised to take into account the grid size and related number of stations per grid when using and interpreting GPCC analyses. A high grid resolution relates to a low number of stations available for gridded analyses and thus to a higher sampling error. See Fig. 5 below, on which red colours indicate grids with at least 3 stations and green colours mark grids with at least 6 stations. It can be seen, that there are more as well as larger red and green areas on the left figure (grid resolution: 2.5°) compared to the right figure (grid resolution: 1.0°).

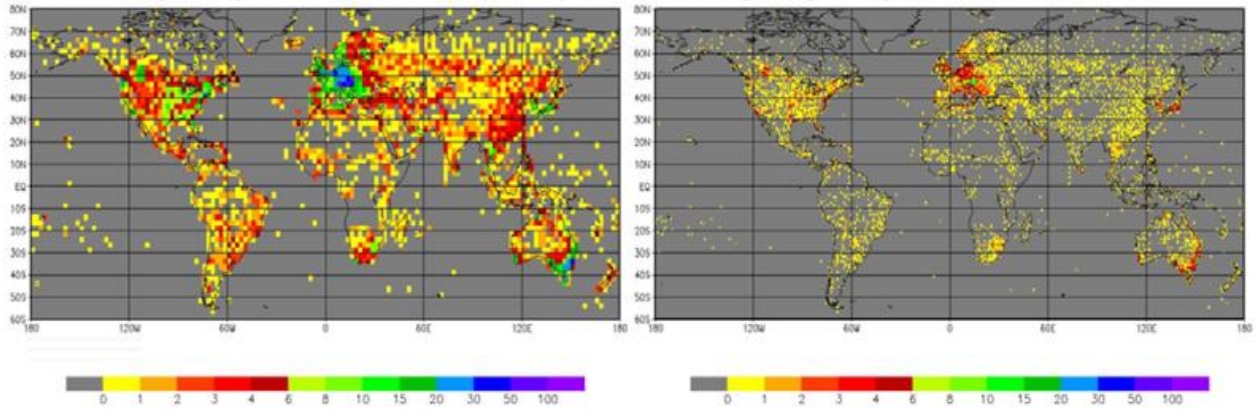


Fig. 5 Number of stations used for each grid of GPCC Monitoring Product analyses of January 2008 (Left: Grid resolution 2.5° x 2.5°; Right: Grid resolution 1.0° x 1.0°)

b) GPCC First-Guess Product

This product, which is available a few days after the end of the month, is based only on monthly precipitation totals calculated from SYNOP reports received at DWD (Offenbach) in near real-time (ca. 5,700 stations). The monthly precipitation totals undergo only an automatic pre-control, but no additional visual quality-control. The most recent analysis month is March 2008. Global precipitation anomalies based on the First-Guess Product are provided via Internet.

c) GPCC Full Data Product

The GPCC Full Data product Version 3 analyses based on the full GPCC database (near-realtime and non-realtime) of February 2005 are available for the period 1951 to 2004 on 0.5°, 1.0° and 2.5° grid resolutions. The GPCC Visualiser has been enlarged in year 2006 to display also the GPCC Full Data product in 0.5 x 0.5° grid resolution. A new version of the Full Data Product based on a significantly enlarged database will be available by May 2008.

d) GPCC VASClimO Product

The GPCC VASClimO product Version 1.1 analyses based on nearly complete and homogenised time series extracted from the full GPCC database (near-realtime and non-realtime) of January 2005 are available for the period 1951 to 2000 on 0.5°, 1.0° and 2.5° grid resolutions. This product is optimised for climatological analyses of precipitation variability and trends. A new version of VASClimO based on a significantly enlarged database will be available by the end of year 2008.

3) Other GPCC Matters

Visitors at GPCC during year 2007

March 2007:	Dr. C. Jacob, EUMETREP, Brussels, Belgium
June 2007:	Dr. George Wilson, Meteorological Services Department, Accra, Ghana
July 2007:	Visitors group from University of Cologne, Germany
July/August 2007:	Mr. U. Riediger (Trainee from University of Frankfurt/Main, Germany)
August 2007:	Dr. J. Cullmann, National IHP/HWRP Secretariat, Koblenz, Germany
September 2007:	Dr. Leprenz, University of Stuttgart, Germany
November 2007	Dr. Anyuan Xiong, China Meteorological Administration, Beijing, China
December 2007	Dr. Akiyo Yatagai, Research Institute for Humanity and Nature, Kyoto, Japan

GPCC related outreach activities in 2007

Oral presentation at event	*Date*	*Location*
Visit at Croatia Met Service	05 March 2007	Zagreb (HR)
XXIV IUGG General Assembly	09 July 2007	Perugia (IT)
Visit of CMA delegation at DWD	30 August 2007	Offenbach (DE)
Visit of ECMWF delegation at DWD	30 August 2007	Offenbach (DE)
3rd Int. Conference on Climate and Water	03-05 Sept. 2007	Helsinki (FI)
GEWEX GRP WGDMA Meeting	05-07 Sept. 2007	New York (US)
ECSN Data Management Workshop	21 November 2007	Vienna (AT)
Visit of Roshydromet delegation at DWD	22 November 2007	Offenbach (DE)
Center for Environmental Systems Research	03 December 2007	Kassel (DE)

Participation at event	*Date*	*Location*
10th Session of IPCC WG I	29 Jan – 1 Feb 2007	Paris (FR)
14th WMO Congress	21 - 25 May 2007	Geneva (CH)
5th National GCOS Meeting	11 June 2007	Offenbach (DE)
CBS Lead Center for GCOS Meeting	05 – 08 Nov 2007	Teheran (IR)
Coordination GRDC/GPCC/FRIEND	17 December 2007	Koblenz (DE)

A new GPCC poster (see Fig. 8) has been compiled in year 2007 for the European exhibition at the 4th plenary meeting of the Group on Earth Observations (GEO-IV), 28-30 Nov 2007, Capetown, South Africa. GEO-IV listed the GPCC among the first 100 Early Achievements towards the implementation of the Global Earth Observation System of Systems (GEOSS).

Global Precipitation Climatology Centre staff at DWD during year 2007

GPCC head: Mr. T. Fuchs

Scientific staff members: Mr. Udo Schneider (deputy GPCC head), Mrs. Anja Meyer-Christoffer

Data administrator and programmer: Mr. Peter Finger

Technical assistants: Mr. Jan Nicolas Breidenbach, Mrs. Astrid Heller, Mr. Peter Stender.

In addition, the former GPCC head Dr. Bruno Rudolf guides the GPCC-activities

GPCC contact details

Common email address: gpcc@dwd.de
Tel.: +49 - 69 - 8062 2872
Fax: +49 - 69 - 8062 3759

Mail-Address:
Deutscher Wetterdienst
Business Unit Climate and Environment
Division KU42
Global Precipitation Climatology Centre
P.O. Box 10 04 65
D-63004 Offenbach am Main, Germany

GPCC Homepage: http://gpcc.dwd.de/
The GPCC homepage has been newly designed and updated at the begin of year 2008.

***Fig. 6** New layout of the GPCC homepage*

GPCC Internet and FTP contacts

Fig. 7a indicates, that the accesses to the GPCC Website have increased by factor 2 since Jan 2004 to more than 8000 hits most of the months of year 2007. Between 1000 and 2000 visitors (in March 2007: 4000 visitors!) at the GPCC Visualiser have been counted during each month of year 2007. Fig. 7b shows monthly access numbers to the different GPCC Monitoring Product features: The most popular product in 2007 was the GPCC Monitoring Product in 1° x 1° grid resolution.

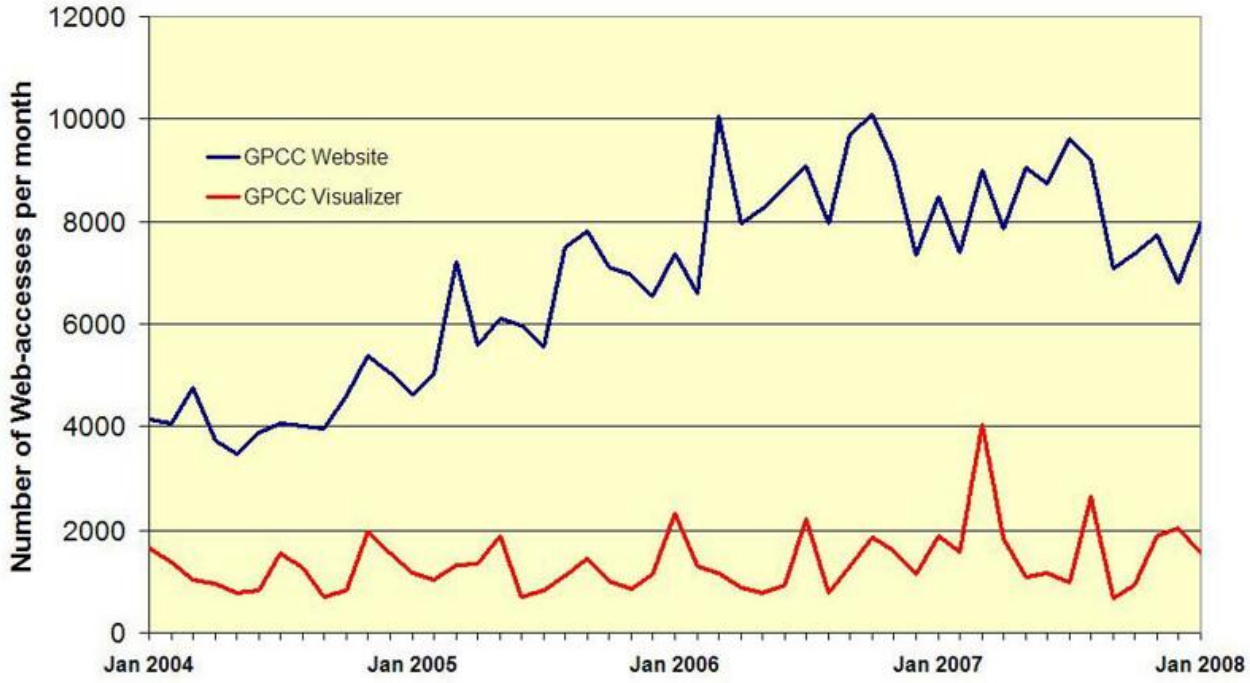


Fig. 7a *Number of GPCC Website and Visualizer accesses during 2004- 2007*

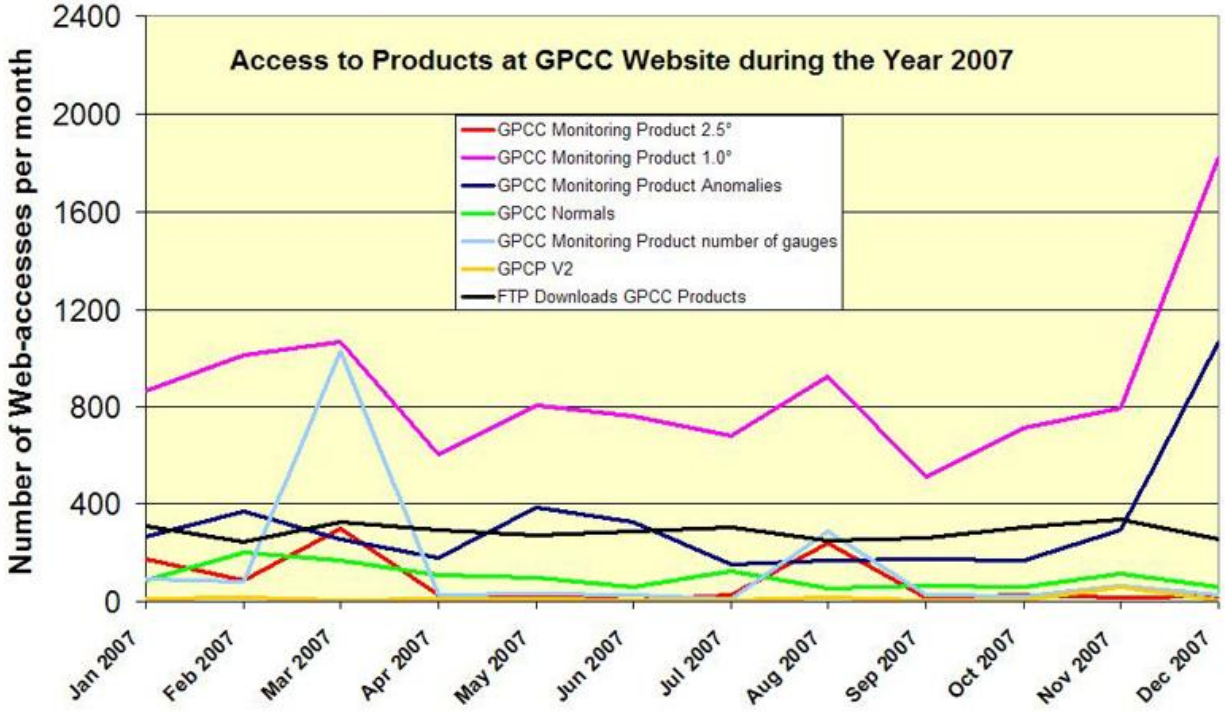


Fig. 7b *Number of accesses to products on the GPCC Website during 2007*

Deutscher Wetterdienst
Global Precipitation Climatology Centre (GPCC)

The GPCC – a German contribution to GEOSS

Motivation

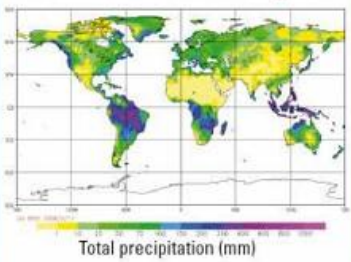
Precipitation is the main freshwater source for the land surface of the earth. Thus it is essential to sustain life on Earth and it is crucial for all environmental issues related to weather and climate.

Precipitation has a large spatial and temporal variability.
Its extremes can trigger major flood and drought related disasters.

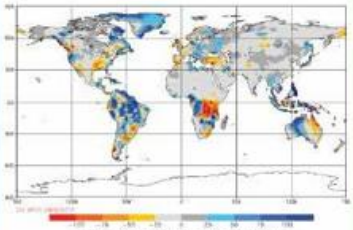
International Framework

GPCC is implemented since year 1989 at the Deutscher Wetterdienst (DWD) under auspices of WMO as a German contribution to the World Climate Research Programme (WCRP) and to the Global Climate Observing System (GCOS).

GPCC Product examples



Total precipitation (mm)



Precipitation anomaly (%)

Data base

GPCC holds the largest monthly in situ precipitation data base of the world comprising more than 1.5 million station years (since 1951) from about 78,000 stations. It highly acknowledges the data contributions by ca. 180 countries.

Task

GPCC analyses the spatial and temporal distribution of global land surface precipitation on monthly time scale based on rain gauge data from in situ EO rainfall networks.

Products

GPCC provides monthly near real-time and non-realtime precipitation analysis products on 0.5° x 0.5°, 1.0 x 1.0°, 2.5° x 2.5° grid cells for monitoring and research of the earth's climate.

Some users of GPCC gridded data sets and their applications

- GEWEX — Adjustment of satellite-based EO and analyses of hydrometeorological processes
- FAO, UNEP — Near real-time drought monitoring
- GCOS — Global climate monitoring
- CLIVAR, IPCC — Climate variability and change analyses
- UNESCO, WMO — Water resources assessment
- more than 2000 scientists working on many different research activities

GPCC products are adjusted to the needs of different user communities and contribute to applications in the GEOSS Societal Benefit Areas water, climate, weather, disasters, agriculture.

GPCC products are freely available via Internet http://gpcc.dwd.de

Fig. 8 GPCC poster presented at the GEO-IV plenary meeting Cape Town, South Africa, 28-30 Nov 2007