GPCC Report for years 2009 and 2010

Development of the GPCC Data Base and Analysis Products

Summary

I. Data Base

Until end of 2010 monthly precipitation data from 190 WMO member countries have been received, processed and integrated into the GPCC database, which is continuously complemented with regard to spatial as well as temporal coverage. The GPCC highly appreciates the assistance by all the countries having supplied observed precipitation data. During more than two decades since its origin in year 1989 the largest global monthly *in situ* observed precipitation station database of the world (data from about 85 000 different stations world-wide) has been compiled at GPCC. The database has been intensively quality controlled in context of the preparation of the new 2010 GPCC products: the Global monthly precipitation climatology and the Full Data Reanalysis Version 5 for the period 1901-2009.

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 6.500 – 8.200 stations. These GTS data have been used as basis for the GPCC near-real-time precipitation Monitoring Product analyses in year 2010.

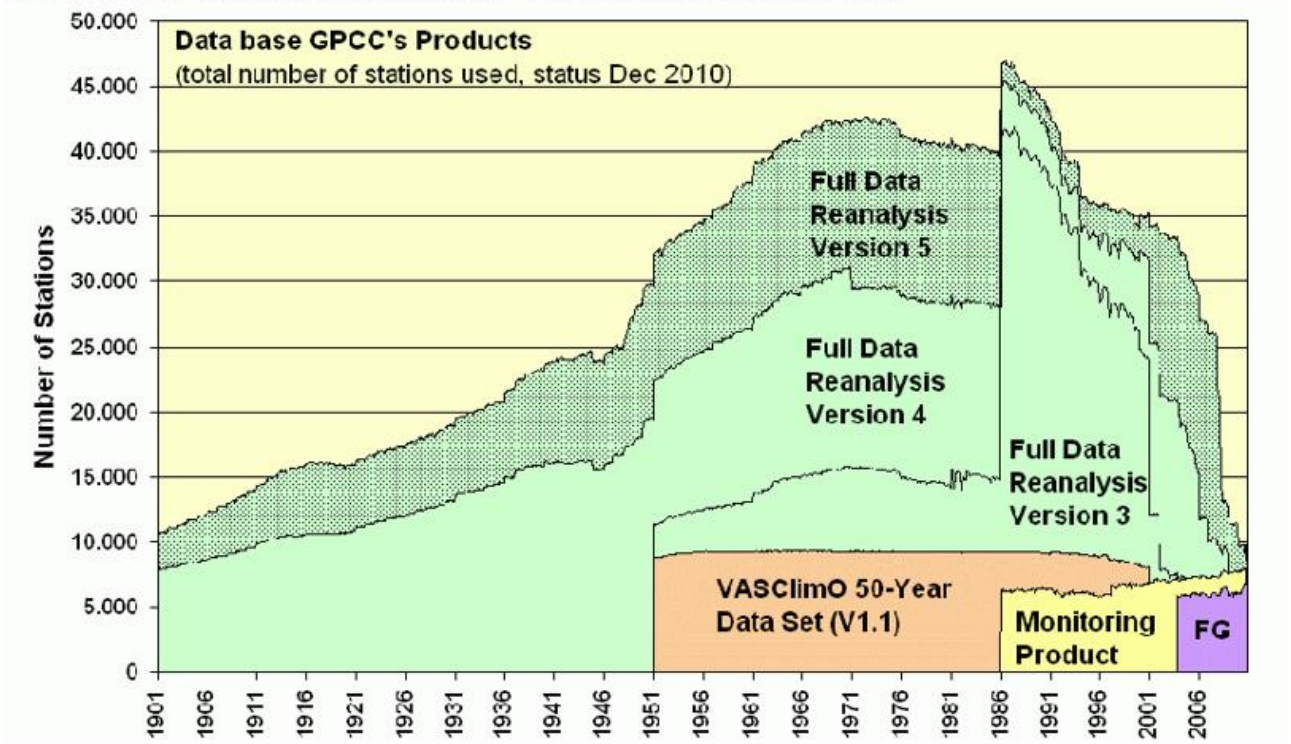


Figure 1 *Composition (number of stations) of the global precipitation station data base of GPCC used for the near real-time "Monitoring Product", for the "Full Data Reanalysis 4" (Version 4 released in Sep. 2008), the latest "Full Data Reanalysis Version 5" (new, December 2010) and for the VASClimO "50-Year Climatology" Version 1.1 (released in August 2005). Moreover the contribution of the stations assessed in near-real-time for the First Guess (indicated by 'FG') and the Monitoring Product is highlighted.*

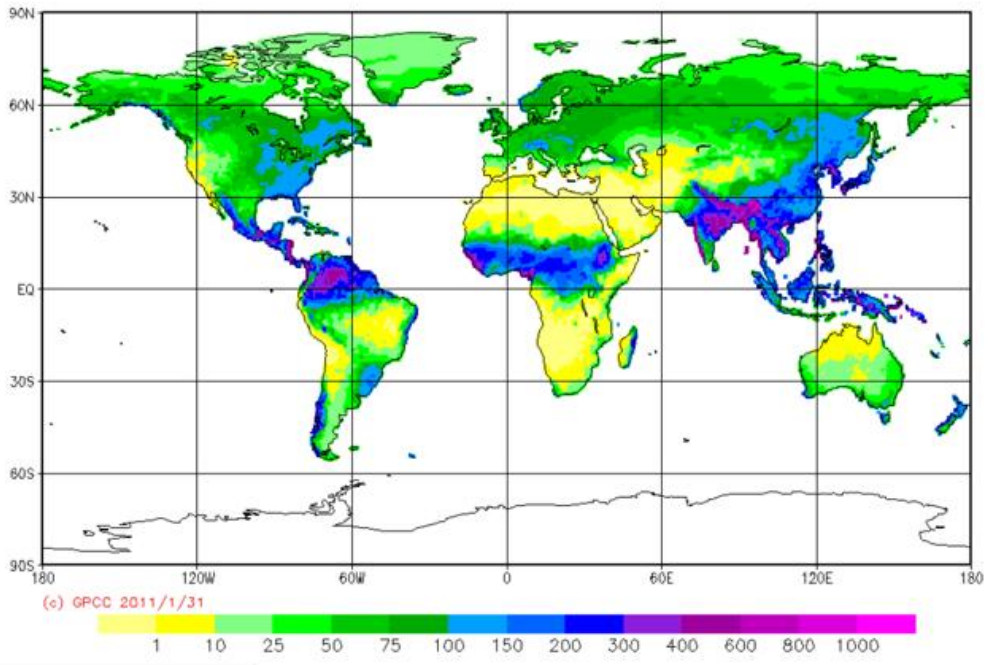
It remains the policy of GPCC not to redistribute or parse any original station data (see Fig. 7 on page 14 for the length and density of the station data contributions by WMO member countries to GPCC) in order to respect the requests of the data owners. The

gridded GPCC products, however, are public accessible via Internet for visualisation and download (http://gpcc.dwd.de). Moreover GPCC remained making the global analysis products mentioned above available as gridded area averaged data in geographical coordinates (grid box resolutions 0.5° latitude by 0.5° longitude and agg regated to 1.0°x 1.0° and 2.5°x 2.5° boxes).

II. Analysis Products

As before, the GPCC continuously processed in years 2009 and 2010 its two near-real-time analysis products, the First Guess of the monthly global land-surface precipitation anomalies (available within 3-5 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 used as an early *in situ* reference for adjustment of satellite-based global precipitation estimates (e.g. Adler et al. 2003[1], Huffman et al. 1995[2], Xie and Arkin 1997[3]). 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, validation of numerical weather forecasts.

Since its last update in May 2008 the ensemble of available observation data has substantially grown, so the GPCC has put intensive efforts to accomplish the next update of its high resolution gridded monthly precipitation climatology (reference period 1951-2000) based on climate means from ca. 64,400 stations (which constitutes a 14,000 stations increase within 30 Months, as far as stations with time series longer than 10 years are concerned). As was true for the previous version, this most recent "GPCC Climatology 2010" is available in four spatial grid resolutions: 0.25°, 0.5°, 1.0° and 2.5°.



[1] Adler, R. F., G. J. Huffman, A. Chang, R. Ferraro, P.-P. Xie, J. Janowiak, B. Rudolf, U. Schneider, S. Curtis, D. Bolvin, A. Gruber, J. Susskind, P. Arkin and E. Nelkin, 2003: The Version-2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation analysis (1979-present). J. Hydrometeorol., 4, 1147–1167.

[2] Huffman, G. J., R. F. Adler, B. Rudolf, U. Schneider, and P. R. Keehn, 1995: Global precipi-tation estimates based on a technique for combining satellite-based estimates, rain gauge analysis, and NWP model precipitation information. J. Climate, 8, 1285-1295.

[3] Xie, P. and P.A. Arkin (1997): Global Precipitation: a 17-year monthly analysis based on gauge observations, satellite estimates, and numerical model outputs. Bull. Amer. Meteo-rol. Soc. 78, 2539 - 2558.

Figure 2: *Example of the new GPCC precipitation climatology (long term mean precipitation for July) in spatial resolution 0.25°x 0.25°.*

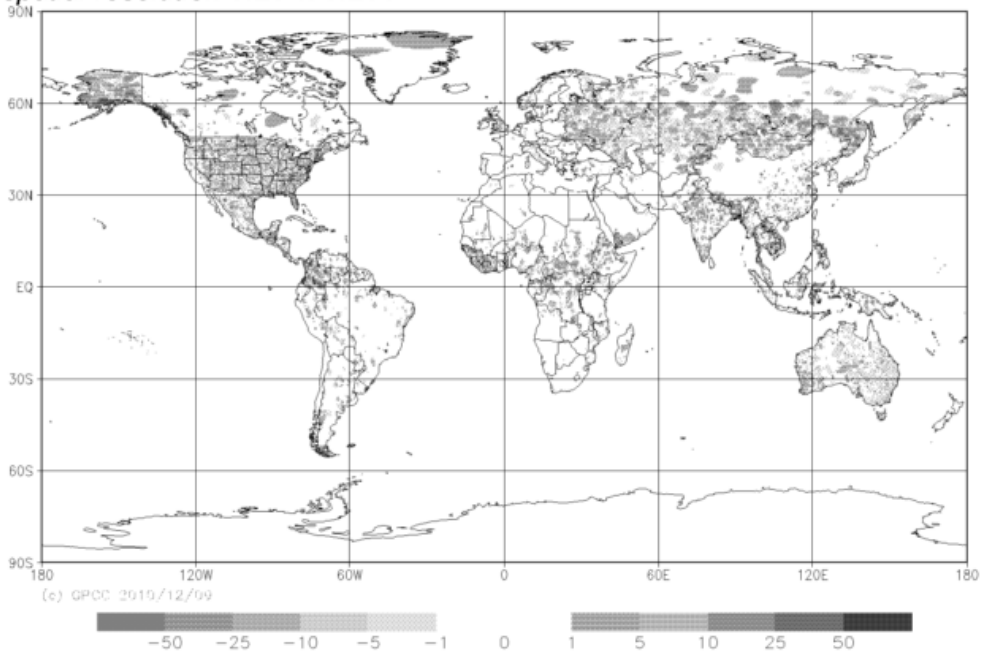


Figure 3 *Comparison of the mean July precipitation climatology produced in 2010 and its predecessor produced in 2008 (difference in mm per month)*

The differences between GPCC Climatology 2008 and 2010 (Figure 3 for July) mainly appear in areas of substantial changes in data coverage and high natural variability (i.e. USA, Russia and Australia for data coverage, and season specific monsoon and ITCZ regions for natural variability). The "GPCC Climatology 2010" and the "GPCC Full Data Reanalysis Version 5" (time series 1901-2009) were put out in December 2010 after an intense test phase and four iterations of gridding and outlier evaluation.

The GPCC Version 5 Reanalysis product is based on all near real-time and non real-time, data in the GPCC data base from stations that have also been used for the 'GPCC Climatology 2010', so there is a climatological normal available for each station involved. The data coverage per month varies from little more than 10,500 in year 1901 to the peak coverage of approx. 47,000 stations in June 1986. The GPCC Full Data Reanalysis Product Version 5 covers the period from 1901 to 2009 and is available in 3 different spatial grid resolutions: 0.5°, 1.0° and 2.5°.

The gridding method applied for all GPCC monthly precipitation analysis methods since year 2008 is based on interpolation of the anomalies from GPCC's high resolution gridded climatology instead of interpolation of the totals, which is a superior method, in particular in regions of data scarcity where the grid values mainly represent the gridded climatology (for example rainfall patterns shaped by the topography) instead of a rather uncertain interpolation from too distant stations. In doing so, the anomalies are spatially interpolated by the analysis method SPHEREMAP (Willmott et al., 1985)[4] and, for the Monitoring and Full Data Version 5 Reanalysis Products, the gridded anomaly analyses are then superimposed on the 'GPCC climatology 2010'. For versions prior to Version 4, this methodology was not feasible, as there were too few stations with sufficiently long data series to form a reliable gridded global background. For comparison we have also applied the 'Ordinary Kriging' method (Krige, 1951)[5].

[4] Willmott, C.J., C.M. Rowe and W.D. Philpot, 1985: Small-scale climate maps: A sensitivity analysis of some common assumptions associated with grid-point interpolation and contouring. *American Cartographer* **12**(1), 5-16.

[5] Krige, D.G., 1951: A statistical approach to some basic mine valuation problems on the Witwatersrand. *J. of the Chem., Metal. and Mining Soc. of South Africa* **52**(6), 119–139.

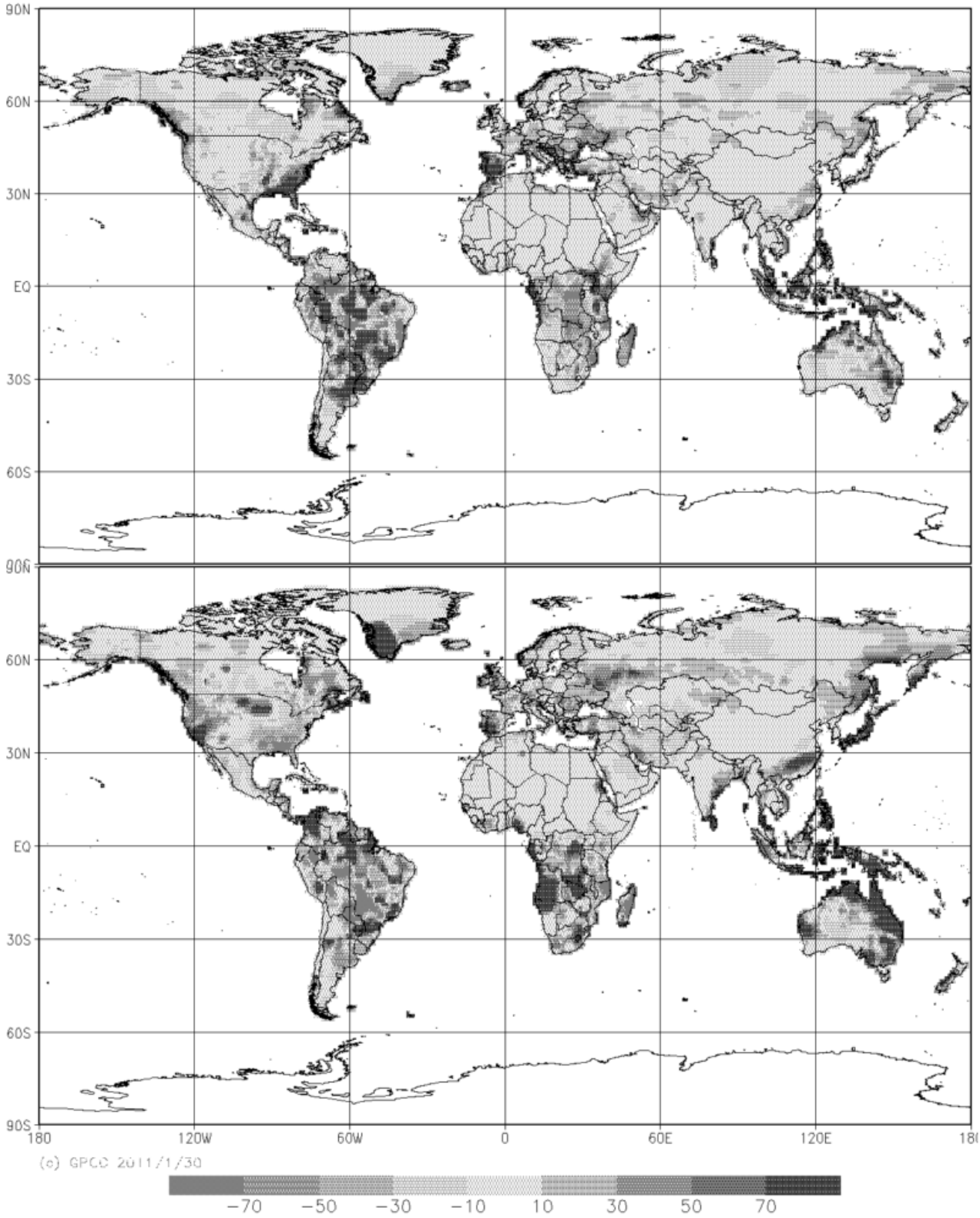


Figure 4 *Example of the new GPCC Full Data Version 5 (upper plot) and First Guess Product (lower plot) analysis: Deviation (mm) of the total annual precipitation in December 2009 (upper plot) and 2010 (lower plot) from the GPCC 2010 climatology, spatial grid resolution 1.0° x 1.0°. The lower plot exhibits anomaly patterns across Australia resulting from the La Niña season.*

The non-realtime GPCC VASClimO product - Version 1.1, available for the period 1951-2000 – has still not been changed. GPCC has modified original plans for Version 2 of VASClimo but will rather develop and release an entirely new Homogenized Precipitation Re-Analysis (HOMPRA) data set throughout this year 2011. It shall cover the period 1951-2005 and should involve approximately 14,000 stations (instead of 9343 stations of VASClimo).

While the Full Data Reanalysis Product provides the best spatial data coverage for each individual month, the VASClimO and the future HOMPRA data set are optimized for completeness and homogeneity for the period 1951-2000 and 1951-2005, respectively. Application of the Full Data product is recommended for water budget studies, but the VASClimO/HOMPRA data sets should be preferred for analysis of temporal climate variability, in particular regarding the spatial distribution of climate change in the ECV precipitation.

III. Point of Discussion put forward to the Panel

In return to requests from a variety of users, GPCC is considering extension of its scope of activities towards continuous monitoring of global daily (new!) and monthly land-surface precipitation based on observations from rain-gauge networks. Depending on its success in acquisition of daily resolving precipitation data sets, GPCC would then develop and define additional gridded data products making best use of the information provided with due consideration to maintain its high quality standards for its suite of products.

GPCC has looked into the feasibility of this endeavour and identified the following major challenges to successfully launch such a project

1. **The daily resolution requires the establishment of another data base for the daily totals and a compilation of a first foundation data set.**
2. **With regard to the sampling error the study of Jenne and Joseph[6] still provides a good estimate on the number of stations required. For example, to keep the sampling error below 20% it would need at least 20-40 stations per 2.5ºx 2.5º grid cell (depending on the season), yielding a global demand of 42,000 – 84,000 land-surface stations.**
3. **GPCC has a certain cadre data set recruited from data archived from the real-time GTS based supplies, from data sets compiled and published externally (alike the NOAA GHCN-daily data set) and from regional (mainly RA-VI) collections**
4. **GPCC plans to contact ECMWF for sharing historic daily data provided by ECMWF member states without restrictions and will strive for bi-lateral agreements with regard to the residual ones**
5. **As is true for its monthly products, GPCC needs legal acceptance from suppliers of daily data and data sets allowing for derivation of new gridded data products from them to be made public available, however, without touching any legal ownership rights on the original data set and data.**
6. **With regard to the data processing, quality control and product development and generation, an ad-hoc assessment by GPCC revealed a demand on DWD in-house resources in the scope of 1 year for R&D and another two years for operational implementation**
7. **GPCC would bind approximately 33% of its existing resources for this extra effort. As was true for its entire efforts in the past, GPCC on behalf of DWD would keep offering its service to the WMO community free of charge.**

GPCC would like to put this proposal forward to the panel, and receive its endorsement. No extra activities from the panel are expected despite the issuance of a new support letter from WMO reflecting the extended scope of GPCCs mandate.

[6] WMO-No. 115, 1985

III. GPCC plans for 2011:

1. **Continuous enlargement of the GPCC database esp. concerning the entire instrumentation periods. Recently a new large data set from Brazil has arrived (see Annex).** These as well as additional datasets received in course of year 2011 will be integrated in the GPCC database;
2. **Development and release of a new Homogenized Precipitation Re-Analysis (HOMPRA) Product (adjusted for climate variability and trend analyses) covering the time period 1951-2005 at spatial resolutions 0.5°, 1.0°, and 2. 5°, HOMPRA is planned to become available in course of year 2011;**
3. **Publication of GPCC reference publications, with one to be submitted to Earth System Science Data (ESSD)[7] journal introducing the GPCC data set and analysis products,** so it can be cited in assessment reports like IPCC AR5;
4. **Ongoing contribution to the Re-Analysis of the monthly gauge-satellite combined products of the WCRP GEWEX Global Precipitation Climatology Project (GPCP)** despite its migration from NASA GFC to NOAA NCDC;
5. **Introduction of a daily GPCC near real-time precipitation monitoring product based on GTS based SYNOP data for areas of sufficient coverage**
6. **Extension of GPCC data acquisition to daily and sub-daily data where appropriate in view of heterogeneous data policies on side of suppliers**
7. **Inclusion of temperature parameter and development of new products making use of combined temperature and precipitation information (e.g. for evaporation diagnosis).**
8. **Another update and enlargement of the functionalities of the "GPCC Visualiser", e.g. to allow for cross-comparison of GPCC products (e.g. diff-plots)**

IV. GPCC comments on recent AOPC conclusions and recommendations:

1. **Referring to AOPC XIV Action Item 77, GPCC reference publications are in preparation;**
2. **Concerning the 2nd part of AOPC XIV Action Item 78 further progress has been made. GPCC has been audited by WMO in context of its suggestion via DWD to act as Data Collection and Production Center (DCPC) under the new WMO Information System (WIS). However, the final WMO approval/designation has not yet arrived GPCC.**
3. **Referring to AOPC XV Action Item 16, reference is made to paper 5.5 of AOPC-XVI.**
4. **Referring to AOPC XV Action Item 65, GPCC is grateful for the most recent WMO letter of appreciation to DWD for its 20 years anniversary in hosting and supporting the GPCC.**
5. **Referring to AOPC XV Action Item 66, GPCC is grateful for the most recent WMO circular letter of May 2009 asking for NMSs support of GPCC by provision of real-time monthly precipitation data. GPCC wishes to enter into discussions on an update of this circular letter, in order to reflect its plans of product extensions exploring also daily totals.**

[7] http://earth-system-science-data.net/

V. GPCC suggestions for AOPC XVI action:

1) Enter into discussion on a new circular letter to the WMO members re-emphasizing the importance of the GPCC activities incl. its achievements after over 20 years of work, taking note of GPCC plans to extend its scope of activities by development of new gridded products based on daily observations and asking NMHSs for support of GPCC by provision of historic (non-real-time) daily and monthly precipitation station data

2) Continue GPCC data acquisition support via WMO Secretariat (e.g. WCP) in case of GPCC communication problems with WMO members;

3) Further improvement of error correction information with regard to systematic gauge measuring error could be achieved, if information on gauge type, installation and site would be internationally exchanged (and by that made available to GPCC). Particular problems occur if WMO members have to re-assign station Id's from closed stations too quickly, challenging the WMO catalogue maintenance. WMO WWW activity might be needed in this context, e.g. to provide for an additional block of station Id's for those members being short on this;

4) GPCC notices substantial improvements made in the previous years in addressing major GTS deficiencies, (e.g., concerning CLIMAT availability from Southern Africa). Anyway further efforts towards a fully homogeneous situation are necessary. GPCC fully supports ongoing joint activities of GCOS and WWW in close cooperation with the CBS Lead Centres for GCOS data and NMHSs in the region.

VI. 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 by DWD via GTS and through direct supplies from JMA, UK Met Office and NOAA-CPC, comprising a total number of up to 8000 stations (Fig. 5). 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-real-time GPCC Monitoring analyses.

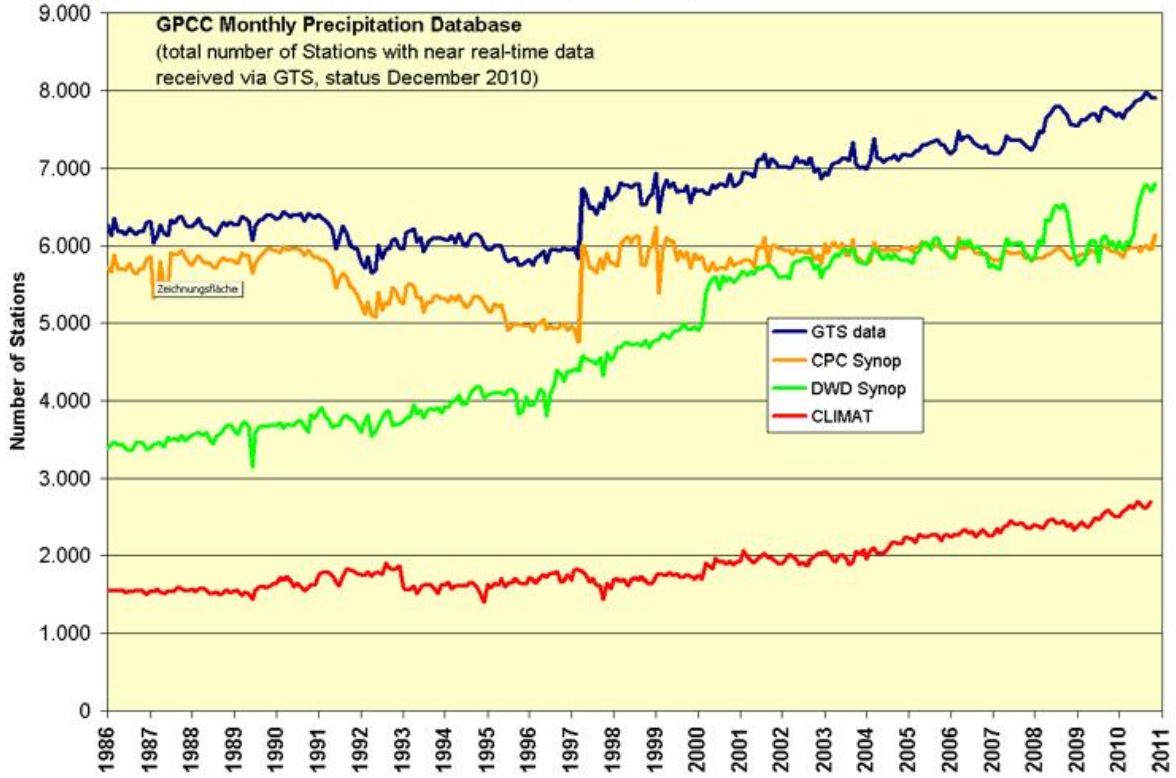


Figure 5 *Total number of stations (blue contour) received via GTS from 1986 until end of 2010. In addition the three sources forming the total (NOAA/CPC and DWD SYNOP and CLIMAT) are also depicted by orange, green and red contours.*

b) GPCC Full Data Base

During years 2009 and 2010 GPCC received additional monthly precipitation data from 48 and 24 countries, respectively. *Please note: GPCC is not able to distribute station-related observational data to others in order to respect the interests of the data suppliers.*

Table 1: Data deliveries of individual countries to GPCC during year 2009

Country	Number of Stations	Data period	Parameter	Date of Delivery
Albania	13	2007-2008	monthly precipitation	16.02.2009
Austria	311	2007	monthly precipitation	26.01.2009
	302	2008	monthly precipitation	17.08.2009
Bahrain	1	1948-September 2009	monthly precipitation	05.10.2009
Bangladesh	35	1948-2008	daily precipitation	01.07.2009
Belarus	47	1961-1985	monthly precipitation	26.01.2009
	47	1997-2008	monthly precipitation	26.01.2009

Country	Number of Stations	Data period	Parameter	Date of Delivery
Belgium	25	2007-2008	daily precipitation and air temperature	03.12.2009
	25	2007-2008	monthly precipitation and air temperature	03.12.2009
Boliva	29	1942-2009	monthly precipitation	26.06.2009
Cambodia	162	1960-1970	monthly precipitation	13.04.2009
Colombia	150	1910-April 2009	monthly precipitation	17.06.2009
Cyprus	9	2008-May 2009	monthly precipitation	10.06.2009
Czech Republic	69	2008	monthly precipitation	16.02.2009
Denmark	Jul 16	December 2008 - November 2009	monthly precipitation	periodic
Ecuador	11	1921-2008	monthly precipitation	01.07.2009
Egypt	28	2008	monthly precipitation	20.07.2009
El Salvador	3	1971-2008	daily precipitation	02.07.2009
Ethiopia	17	1951-2008	daily precipitation	26.06.2009
Gabon	1	1950-2000	monthly precipitation	24.10.2009
	14	1961-1990	climatological normals	24.10.2009
Greece	52	2001-2008	monthly precipitation	14.07.2009
Guatemala	36	1990-2008	monthly precipitation	24.11.2009
Italy	166	1951-June 2009	monthly precipitation	30.07.2009
	33	November 2008 -October 2009	daily precipitation and air temperature	periodic
Latvia	6	2008	daily precipitation	04.03.2009
	21	2008	monthly precipitation	04.03.2009
Macao	2	1952-May 2009	monthly precipitation	26.06.2009
Macedonia	12	2008	monthly precipitation	19.08.2009
Malaysia	37	2008	monthly precipitation and air temperature	04.02.2009
Maldives	2	1974-2009	daily precipitation	29.09.2009
Mongolia	124	1937-2008	monthly precipitation	13.02.2009
Mozambique	29	2007-2008	monthly precipitation	06.08.2009
Namibia	79	1994-2008	monthly precipitation	16.06.2009
Netherlands	96	November 2008 October 2009	daily precipitation	periodic
Niger	15	1905-2008	monthly precipitation	16.07.2009
Norway	855	1999-2008	monthly precipitation	25.02.2009
Oman	25	1942-2008	monthly precipitation	13.07.2009
	36	1942-2008	monthly precipitation	23.08.2009
Pakistan	53	2005-2007	monthly precipitation	07.02.2009
Poland	140	2008	monthly precipitation	20.04.2009
Russia	223	1966-2007	monthly precipitation	11.08.2009
Seychelles	5	1971-2008	monthly precipitation	26.06.2009
Slovakia	45	July-December 2008	monthly precipitation	02.04.2009
	45	1901-2000	monthly precipitation	26.06.2009
	45	January-June 2009	monthly precipitation	16.10.2009
Slovenia	57	2005-June 2009	monthly precipitation	21.07.2009
South Africa	769	2006-2008	monthly precipitation	22.05.2009
Switzerland	427	2008	monthly precipitation	12.02.2009

Country	Number of Stations	Data period	Parameter	Date of Delivery
Thailand	84	2007-2008	monthly precipitation	16.06.2009
	84	1951-June 2009	monthly precipitation	14.07.2009
Togo	39	1901-2005	monthly precipitation	08.06.2009
Turkey	278	1996-2007	monthly precipitation	31.03.2009
Uganda	17	2008	monthly precipitation	30.01.2009
United Arab Emirates	11	1974-2008	daily precipitation	12.06.2009
United Kingdom	436	2007	monthly precipitation	20.01.2009
Usbekistan	71	2008	monthly precipitation	15.04.2009
Vietnam	33	1956-2008	monthly precipitation	27.11.2009

Table 2: Data deliveries of individual countries to GPCC during year 2010

Country	Number of Stations	Data period	Parameter	Date of Delivery
Cote d'Ivoire	120	1905-2000	monthly precipitation	03.02.2010
Austria	295	2009	monthly precipitation	19.08.2010
Belarus	55	1990-2009	daily precipitation	02.06.2010
Bhutan	25	2008-2009	daily precipitation	15.11.2010
Botswana	29	2007-2009	monthly precipitation	17.08.2010
Brazil	tbd	tbd	daily precipitation	23.11.2010
Canada	tbd	1840-1993, 2001-2003, 2004-2009	daily precipitation, monthly precipitation and snow depth	12.05.2010
Czech Republic	68	2009	monthly precipitation	08.02.2010
Denmark	296	1991-2009	monthly precipitation	26.05.2010
	296	1961-1990	climate normals	26.05.2010
	242 - 271	December 2009 -October 2010	monthly precipitation	periodic
Dominican Republic	23	2009	daily precipitation	18.04.2010
	71	1931-July 2010	monthly precipitation	16.09.2010
France	4578	2008-2009	monthly precipitation	27.10.2010
Ireland	206	1840-2009	monthly precipitation	11.06.2010
Israel	13	1945-August 2010	monthly precipitation	06.10.2010
Italy	33	November 2009 - November 2010	daily precipitation and air temperature	periodic
Japan	156	1876-2009	monthly precipitation	20.10.2010
Latvia	21	2009	monthly precipitation	05.03.2010
	6	2009	daily precipitation, air temperature and snow depth	05.03.2010
Lithuania	20	1971-August 2010	monthly precipitation	15.10.2010
Nepal	125; 276	1947-1970; 2005-2007	monthly precipitation	28.11.2010
Netherlands	96	November 2009 October 2010	daily precipitation	periodic
Poland	140	2009	monthly precipitation	30.03.2010
Slovakia	45	July 2009 -December 2009	monthly precipitation	29.03.2010
	45	January -June 2010	monthly precipitation	24.11.2010
Switzerland	427	2009	monthly precipitation	11.02.2010
United Kingdom	554	2008	monthly precipitation	08.02.2010
Uzbekistan	71	2009	monthly precipitation	31.03.2010

Processing of the additionally delivered national/regional data sets (incl. quality control of metadata and observation data) and inserting them into GPCC's RDBMS is a continuous GPCC activity. Fig. 6a 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 1900-2010. Data provided by a national weather service is regarded to origin form a primary data source. This data from 190 countries (Figure 7) origins directly from the producer and constitutes the major compartment of the GPCC data base. Moreover the GPCC receives the daily SYNOP and the monthly climate (CLIMAT) messages while listening to the WMO GTS. To be comprehensive in its approach, the GPCC integrates also other global precipitation data collections from the Food and Agriculture Organisation (FAO), the Climate Research Unit (CRU) of the University of East Anglia, and the Global Historical Network (GHCN) as well as several regional data sets. As an example for the latter, the important data set from Nicholson (1979) was integrated recently to still become part of the new products. In total of these efforts the GPCC owns the worldwide largest and most comprehensive collection of precipitation data, which is continuously extended. However, it should be noted that in dependence of its source, data arrives sooner or later in comparison to its time reference.

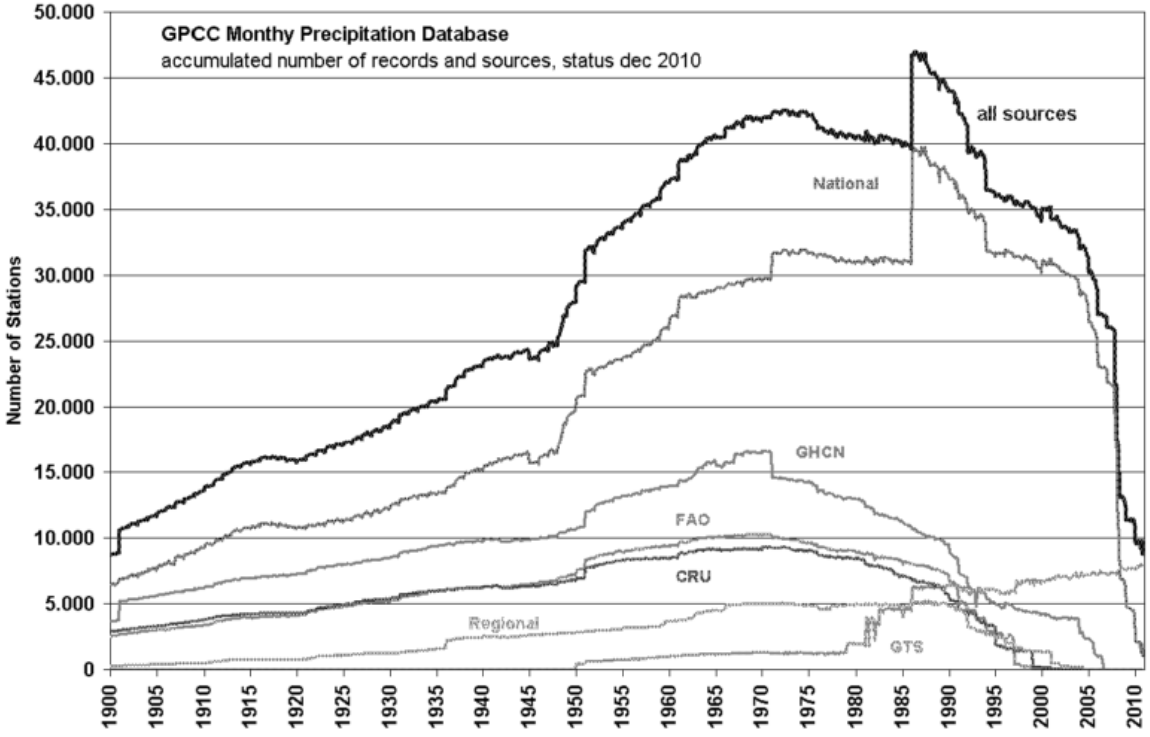


Figure 6a: *Number of monthly precipitation data in the GPCC data base as a function of time for the different data sources in the GPCC database.*

Fig. 6b shows the evolution of the GPCC Monthly Precipitation Database throughout the dates of issuance of the latest four Versions of its Full Data Re-Analysis Product, which is only done after substantial growths of the data base. 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 in particular for the last update from Version 4 to 5. So the gap from 1986 to the years before is almost balanced.

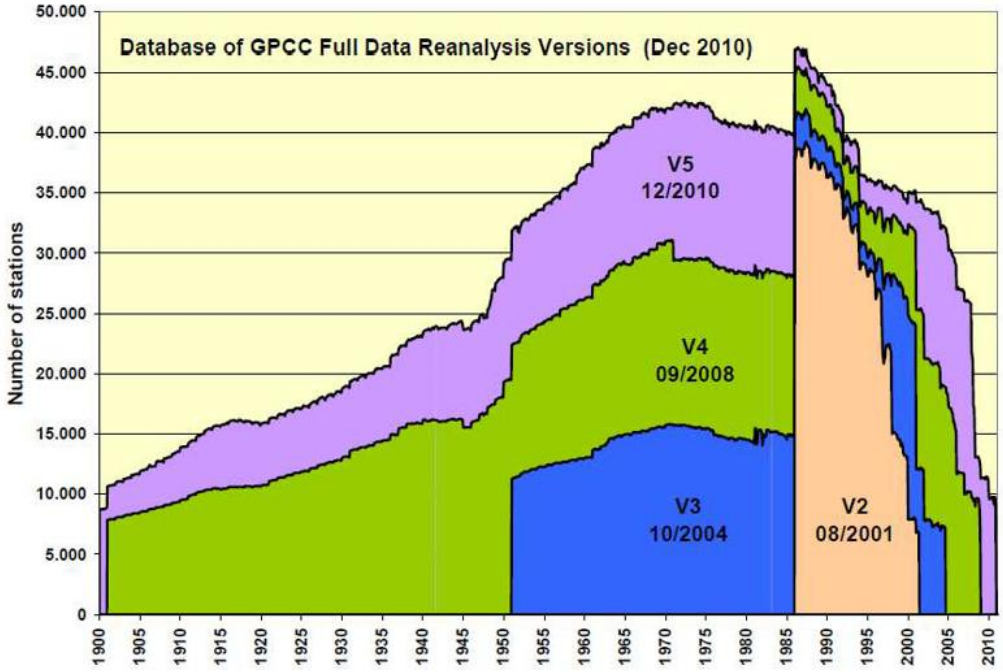


Figure 6b: *Growth of the GPCC data base in terms of number of precipitation gauge stations per data month integrated. For evolution stages are depicted, concurrent with the dates of issuance of Versions 2 (2001), 3 (October 2004), 4 (September 2008) and 5 (December 2010).*

Fig. 6c shows the evolution of the number of station months in the GPCC Monthly Precipitation Database (decades with data from 1901 onwards) during the period June 2003 until December 2010. It indicates that the extension of the GPCC data base concerning historical data (data before year 1951) started in 2007. The historical extension of the GPCC data base during the last 7 years is very visible by looking at the decades with data before year 1981. Altogether the number of station months almost increased by a factor of 3.5 during the last 6.5 years.

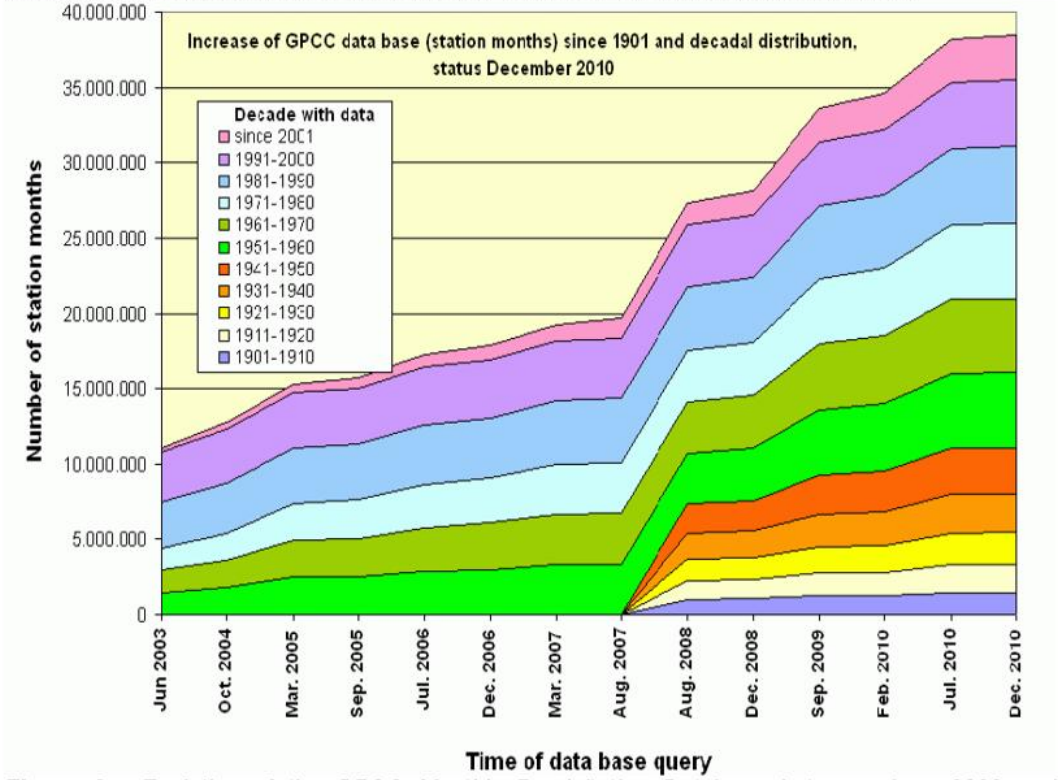


Figure 6c: *Evolution of the GPCC Monthly Precipitation Database between June 2003 and December 2010 (Number of station months per date of data base query)*

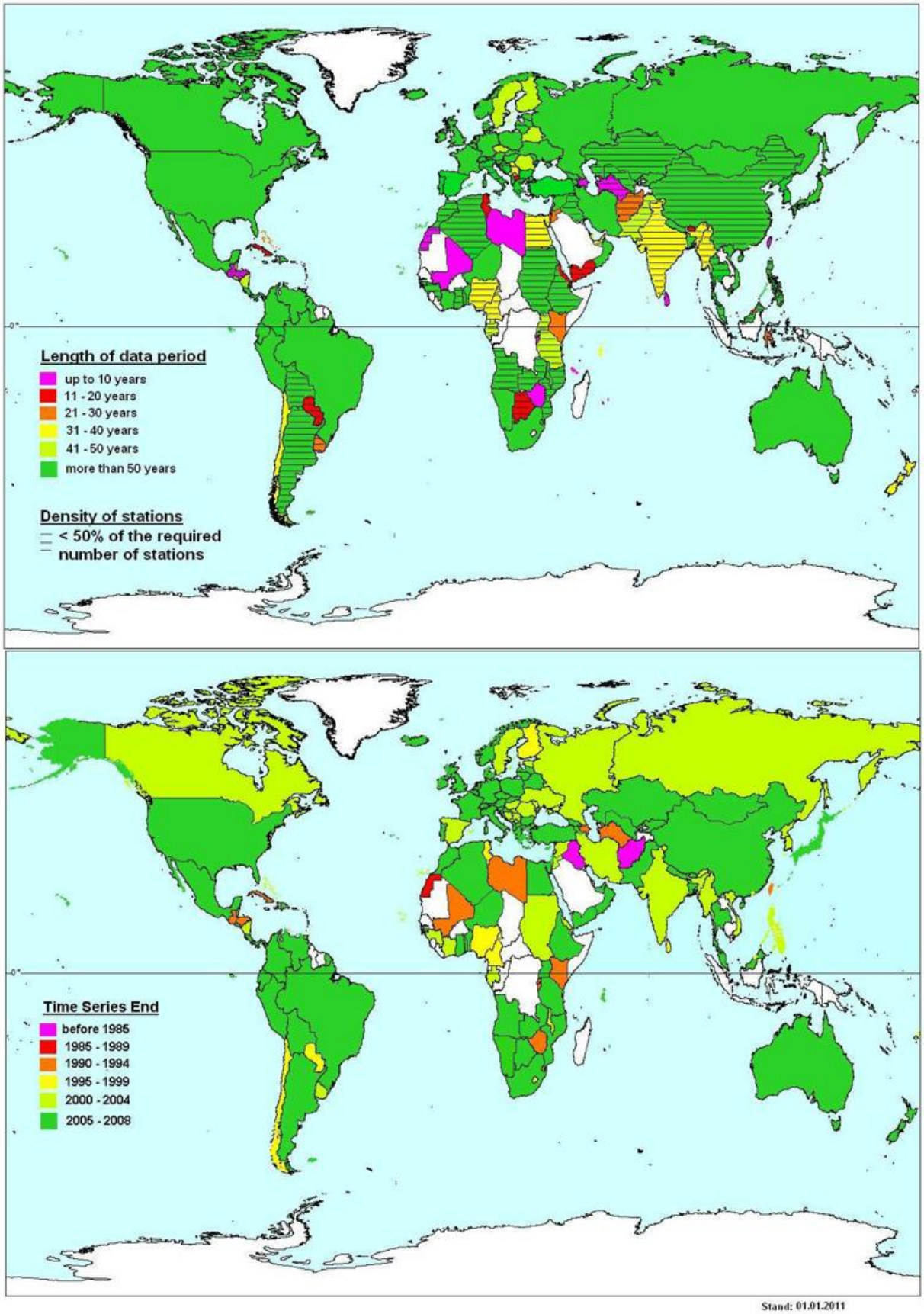


Figure 7: *Contributions of historic precipitation data sets by WMO member countries to GPCC in terms of length of data period covered and most recent historical data involved.*

Figures 8a-f show 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) used for GPCC Full Data Reanalysis Version 5 available since December 2010. Green, blue and magenta colours indicate grids with a sampling error of less than 10 % of the precipitation total on the grid.

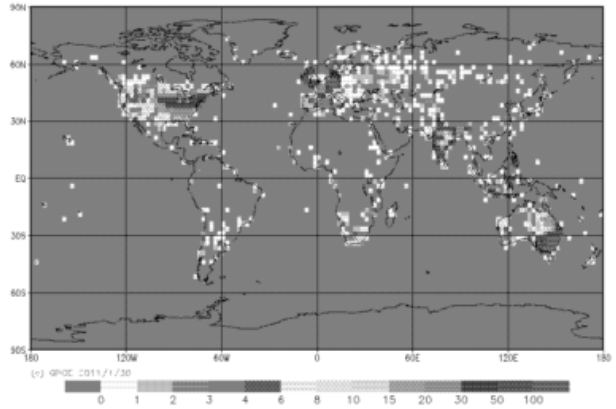


Fig. 8a *Spatial distribution of the number of stations used for the new GPCC Full Data Reanalysis Version 5 analysis with 2.5°x 2.5°grid resolution Month: July 1901, Total number of stations: 10754*

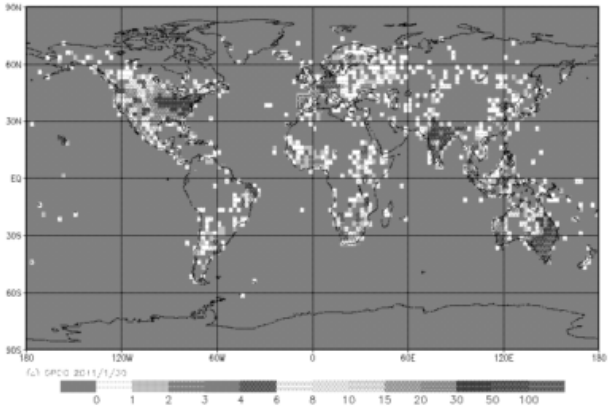


Fig. 8b *Spatial distribution of the number of stations used for the new GPCC Full Data Reanalysis Version 5 analysis with 2.5°x 2.5°grid re solution Month: July 1921, Total number of stations: 16363*

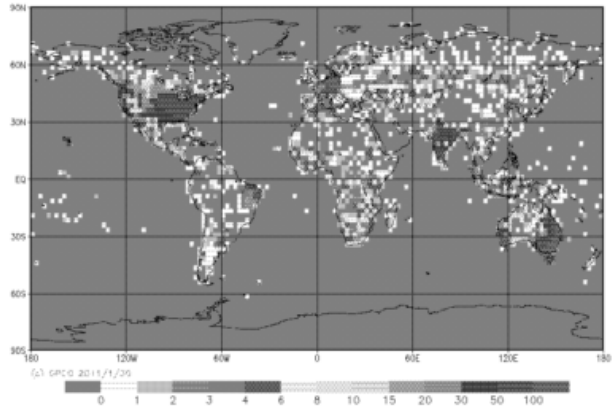


Fig. 8c *Spatial distribution of the number of stations used for the new GPCC Full Data Reanalysis Version 5 analysis with 2.5°x 2.5°grid resolution Month: July 1941, Total number of stations: 23876*

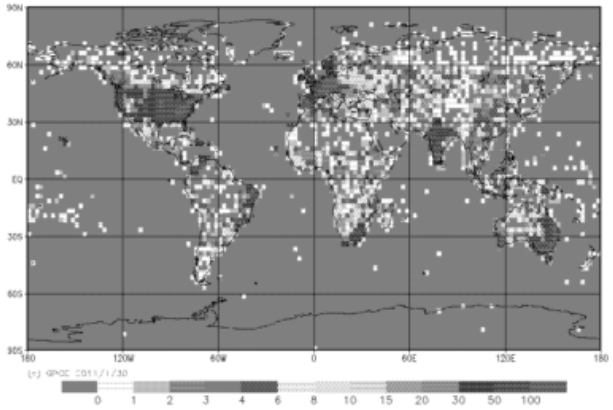


Fig. 8d *Spatial distribution of the number of stations used for the new GPCC Full Data Reanalysis Version 5 analysis with 2.5°x 2.5°grid re solution Month: July 1961, Total number of stations: 38699*

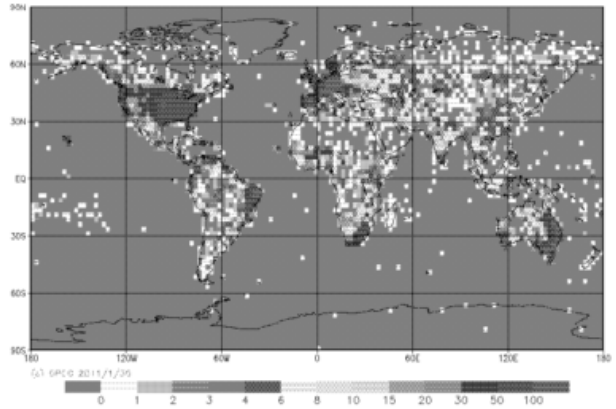


Fig. 8e *Spatial distribution of the number of stations used for the new GPCC Full Data Reanalysis Version 5 analysis with 2.5°x 2.5°grid resolution Month: July 1981, Total number of stations: 40510*

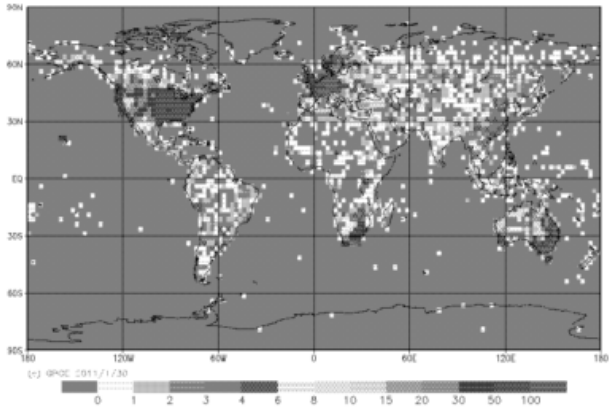


Fig. 8f *Spatial distribution of the number of stations used for the new GPCC Full Data Reanalysis Version 5 analysis with 2.5°x 2.5°grid re solution Month: July 2006, Total number of stations: 27004*

2) Data processing and quality control

The collected data are imported into a relational data base, where they are kept in separate source specific slots (Fig. 10). This methodology allows for a source specific cross-comparison of the data. As none of the sources is error free, each source is allowed to provide for the reference information on a case-by-case basis. This is realized by a comparative analysis of data entries from different sources relevant for the same or neighbouring stations, the latter only in cases staying ambiguous if only the station itself is regarded. Typical errors identified during data import are factor-10, factor 2.54 or also factor 25.4 errors due to erroneous inch to mm conversions, shifts of the reference time, or geo-reference errors that had affected the data already before arrival at the GPCC.

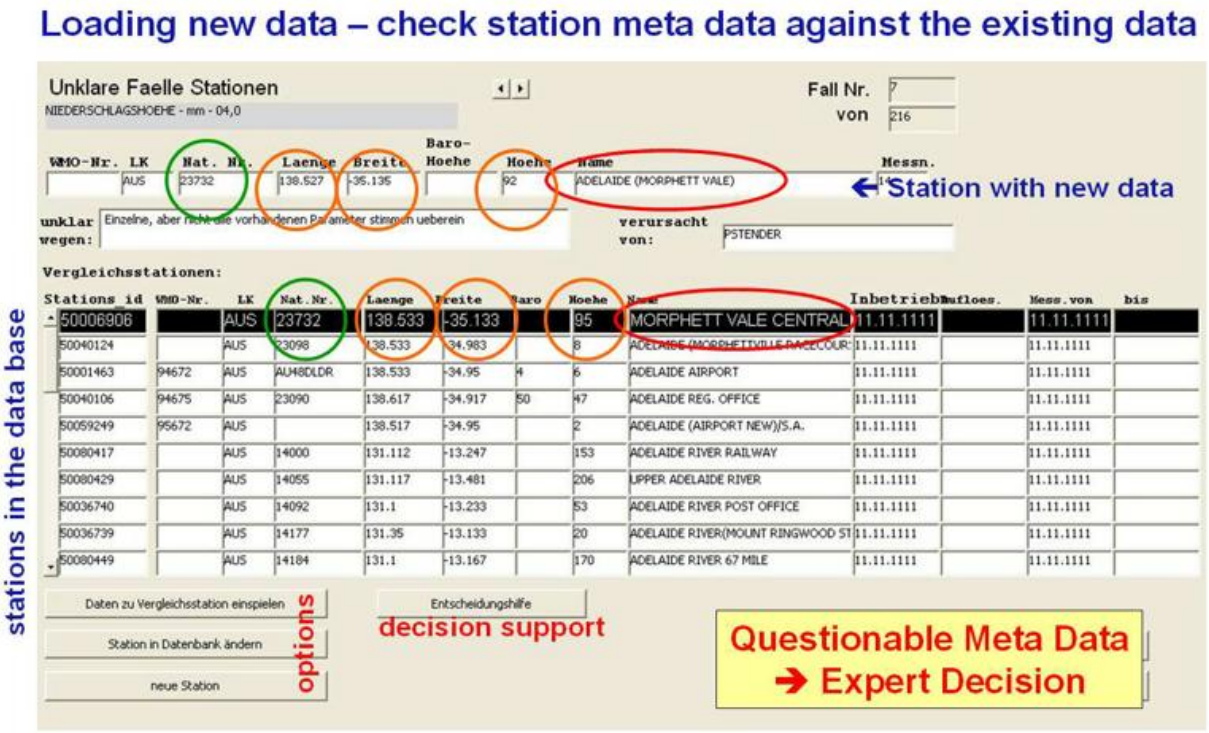


Figure 9 *Snapshot of the graphical user interface showing an example of source specific data import and archival.*

Any time new data is imported to the data base, an elaborated procedure is applied to compare the accompanying metadata of the belonging stations to the metadata already available for this station from the data base (Fig. 9). In case of discrepancies (e.g. deviating coordinates), external geographical sources of information are utilized to decide whether a correction of the metadata information in the data base is required or not. Moreover the precipitation data to be imported is compared against a background statistic. Exceptional values are checked and either confirmed, if possible corrected, or excluded from the product. This approach requires a high level of human interaction, due to the complexity of the error analysis, which varies strongly case by case in the absence of general valid screening criteria. Nevertheless, despite all corrections applied by the GPCC, a set of the original data is also kept, allowing backtracking of all corrections.

Separate storage of the data from different sources

Data for analysis		Station - Meta Information						Precipitation Data separated for the data sources (Dec. 1995)								Dec.
precip	selected	GPCC ID	Name	Continent	lamb	phi	elev	SYNOP	CLIMAT	CPC	Regio	National	CRU	GHCN	FAO	normals
(mm)	source				decimal	decimal	m NN	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
9	National	50000100	Oslo-Blindern	Europe	10,717	59,950	96		9			9	9	9	9	54
28	National	50000092	Turku	Europe	22,267	60,517	59	30	28	29		28	28	28	28	64
60	SYNOP	50002750	Orleans	Europe	1,783	47,983	125	60		62						54
34	National	50000516	Alicante	Europe	5,333	35,333	460	37	34	13		34	34	34	34	34
73	National	50000406	Pescara	Europe	14,200	42,433	11	71		71		73				77
20	National	50000193	Poznan	Europe	16,850	52,417	92	21	20	21		20	20	20	20	38
21	National	50000477	Sivas	Europe	37,017	39,750	1285	23	21	22		21	21	21	21	47
6	SYNOP	50002287	Odense	Europe	10,333	55,467	17	6		8						
25	National	50002508	Sumy	Europe	34,783	50,850	181	26		24	25	25				53
156	National	50000365	Sarajevo	Europe	18,433	43,867	638					156		156		85
51	National	50000492	Cagliari	Europe	9,067	39,250	5	53	49	48		51		49	49	55
72	National	50002788	Kufstein	Europe	12,164	47,575	493	74		71		72				
103	National	50030955	Basel	Europe	7,583	47,533	317	104				103				54
71	National	50														49
73	National	50														46
55	National	50														65
66	National	50														64
69	National	50														
147	National	50														52
95	CLIMAT	50000548	Kalamata	Europe	22,017	37,067	8		95			117	95	95	95	154
64	CLIMAT	50035663	Bet Dagan	Europe	34,817	32,000	35		64				64	64	64	139
156	National	50019414	Kredarica	Europe	13,850	46,383	2515	169	156	155		156				120

The separate storage of the different data sources is an important basis for quality control as well as for understanding and later re-production

Figure 10 Snapshot of the graphical user interface (GUI) covering the calibration of meta-data from a new station (top line on GUI) against similar data already available in the GPCC data base. The meta-data parameters checked in this example, are indicated.

3) GPCC Analysis Products

a) 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. 5,800 – 6,500 stations). The monthly precipitation totals undergo only an automatic pre-control, but no additional visual quality-control. The most recent analysis month is December 2010. Global precipitation anomalies based on the First-Guess Product are provided via Internet.

b) Monitoring Product

The monthly "GPCC Monitoring Product" is available for all months since January 1986, i.e. 287 months. The GTS-based rain-gauge data used for the GPCC Monitoring Product analyses have been processed, and analysed for all months of years 2009 and 2010. All data were quality-controlled on a high level with automatic plus visual checks. After completion of the GPCC Climatology 2010, all Monitoring Products back to January 2007 have been reprocessed.

c) Full Data Reanalysis

The new GPCC Full Data product Version 5 analyses based on the full GPCC database (near-realtime and non-realtime) of December 2010 are available for the period 1901 to 2009 on 0.5°, 1.0° and 2.5° grid resolutions. The former Version 4 products have been kept available as well.

d) 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 Homogenized Precipitation Re-Analysis (HOMPRA) Product based on a significantly enlarged database will be made available in course of year 2011.

For a more thorough description please consult the latest description by Schneider et al. (2010) available from ftp://ftp-anon.dwd.de/pub/data/gpcc/PDF/GPCC_intro_products_2008.pdf

4) Other GPCC Matters

Visitors at GPCC during year 2009 and 2010

05-JUN-09:	Sharon, Nicholson, Dept. of Met., Florida State University, FL, USA
22-APR-09:	CEMAC Commissioner
20-NOV-09:	Delegation from Turkish State Met. Service
10-JUL-10:	Prof. Dr. Franz Rubel, University of Veterinary Medicine Vienna, Austria
05-SEP-10:	Dr. Carolin Richter, Director GCOS Secretariat, Geneva, CH

GPCC related outreach activities in 2009 and 2010

Oral Presentations

18/19-FEB-2009	IMGW, Wroclaw (PL)
16-MAR-2009	RIHN Univ. Kyoto, Kyoto (JP)
17-MAR-2009	Dept. of Geography Tokyo Metrop. Univ., Tokyo (JP)
18-MAR-2009	Institute of Industrial Science Univ. Tokyo, Tokyo (JP)
31-MAR2009	CMA Visitor Group, DWD Offenbach (DE)
27-JUL-2010	HRM Workshop, Langen (DE)

Oral presentation at event	*Date*	*Location*
EGU GA 2009	19 - 23 April 2009	Vienna (AUT)
AOPC-XV	21 - 25 April 2009	Geneva (CH)
Annual Meeting of JpGU	26 – 29 May 2009	Tokyo (JP)
7th Meeting of GEWEX Radiation Panel	16 - 18 September 2009	College Park, MD
CCI ET Meeting on Clim. & Mar. Data & Prod.	27 - 29 October 2009	Offenbach (DE)
2nd Pan-GEWEX Meeting	23 - 27 August 2010	Seattle, WA (USA)
WMO Audit of DWD GISC-DCPC presentations	17 - 20 September 2010	Offenbach (DE)
DACH Meteorologist Symposium 2010	20 - 24 September 2010	Bonn (DE)
IPWG-5 Meeting	11 - 15 October 2010	Hamburg (DE)

Participation at event	*Date*	*Location*
WMO CBS XIV	27-29 MAR 2009	Dubrovnik (HR)
GRDC Steering Committee	24-JUN-2009	Koblenz (DE)
WCC-3	31-MAR – 2AUG 2009	Geneva (CH)
National Meeting on Climate (DKT)	13 Oct 2010	Offenbach (DE)
WMO RA VI RCC-CM	25-27 Oct 2010	Offenbach (DE)
WMO WG CH & CI	28-30 Oct 2010	Offenbach (DE)
AGU Fall 2010 Meeting	17-21 Dec 2010	San Francisco, CA

New GPCC posters have been compiled in year 2009 and 2010 for

- Workshop on New Temperature Climatology, Sep 2010, Exeter, UK
- Workshop on Metrics and Methodologies of Estimation of Extreme, Climate and Weather Events, Sep 2010, Paris, France
- German-Austrian-Swiss Meteorologists Symposium, Sep 2010, Bonn, Germany (Fig. 11)
- Meeting of the International Precipitation Working Group, Oct 2010, Hamburg, Germany
- 2010 GEO Beijing Ministerial Summit, Nov 2010, Beijing, China
- AGU Fall 2010 Meeting, Dec 2010, San Francisco, CA, USA

A GPCC precipitation anomaly map for years 2009 has been provided to WMO and published in the WMO report on the status of the global Climate of year 2009. This will be repeated for year 2010.

Global Precipitation Climatology Centre staff at DWD during years 2009 and 2010

GPCC head:	Dr. Andreas Becker (joined in July 2010)
Scientific staff members:	Mr. Udo Schneider (deputy GPCC head),
	Mrs. Anja Meyer-Christoffer,
	Mr. Markus Ziese (joined in April 2010)
Data administrator and programmer:	Mr. Peter Finger
Technical assistants:	Mr. Peter Stender.
	Mrs. Astrid Heller,
	Mr. Jan Nicolas Breidenbach

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

GPCC contact details

Common email address: gpcc@dwd.de

Tel.: +49 - 69 - 8062 2900 (GPCC Head)
Fax: +49 - 69 - 8062 3759

Mail-Address:

Global Precipitation Climatology Centre
Hydrometeorology Department, KU4
Deutscher Wetterdienst

P.O. Box 10 04 65
63004 Offenbach am Main, Germany

GPCC Homepage: http://gpcc.dwd.de/

Wetter und Klima aus einer Hand

Deutscher Wetterdienst

On the fall 2010 enhancements of the Global Precipitation Climatology Centre (GPCC) data sets

Andreas Becker, Udo Schneider, Anja Meyer-Christoffer, Markus Ziese, Peter Finger, and Bruno Rudolf

Global Precipitation Climatology Centre, Deutscher Wetterdienst, Frankfurter Straße 135, D-63067 Offenbach am Main, Germany, Tel.: +49 69 8062 2900, gpcc@dwd.de

Precipitation

- is crucial to sustain any form of life on earth as major source of fresh water, with major impact on weather, climate, climate change and related issues of societies adaption to the latter
- belongs to the WMO GCOS list of 44 essential climate variables (ECV)

Some facts on GPCC

- performs real-time and re-analysis yielding gridded data sets of global land surface precipitation on monthly time scale based on rain gauge data from in situ earth observation (EO) rainfall networks.
- holds the largest monthly in situ precipitation data set world wide comprising more than 80,000 stations and over 40 million observation months. In doing so the data integrity and ownership of the raw data remains untouched.
- has been implemented in 1989 at the Deutscher Wetterdienst (DWD) and constitutes a German contribution to the WMO World Climate Research Programme (WCRP) and the Global Climate Observing System (GCOS).
- The GPCC analysis products are open available via a web portal (http://gpcc.dwd.de).

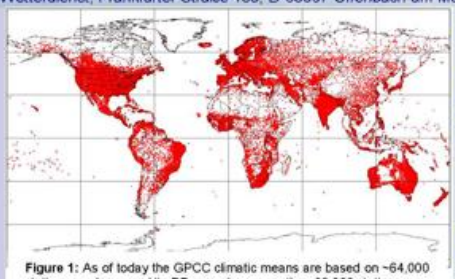


Figure 1: As of today the GPCC climatic means are based on ~64,000 stations as shown and its DB comprises more than 80,000 stations.

Five rules GPCC followed to sustain service level

1. An utmost care taken for the integrity and quality of the data
2. State-of-the-art methods applied for the data interpolation on regular grids
3. Derived products that are tailored to the manifold needs of the broad user community
4. An open ear to the community with regard to product and method enhancements
5. An efficient, successful and sustained data acquisition process supported by WMO

The GPCC *in situ* precipitation station data base

Near real-time data from the Global Telecommunication System (GTS) of the World Meteorological Organisation (WMO):

+

Non real-time data from international projects, historical data collections and more than 190 countries of the world:

=>

GPCC contributes to *in situ* EO Network Monitoring activities of WMO WWW and GCOS; GPCC has the largest global monthly *in situ* EO rainfall data base

Features and timelines of the fall 2010 suite of GPCC precipitation analysis products

Start of GPCC analysis

+ 5d: First Guess Analysis (since 2003)

- the earliest information on precipitation anomalies used for drought monitoring by FAO
- Based on synoptic data received near real-time from approx. 6,500 stations.
- Automatic-only quality-control
- Fig. 2 shows August 2010 patterns that are typical for a La Nina situation during NH summer

+ 60d: Monitoring Product (since January 1986)

- designed for global climate monitoring used for GEWEX/GPCP satellite-gauge combination
- based on SYNOP and monthly CLIMAT reports from approximately 8,000 stations
- High level Quality Control of all (meta-)data used
- Cross-check of SYNOP and CLIMAT observations
- Fig. 3 (top row) shows El Nino Winter 1997/98

~ 2-3 years (upon significant DB enhancements)

New Monthly Global Precipitation Climatology

- Fall 2010 release based on just 64,000 stations (Fig. 1) with at least 10 years of data that went through QA/QC
- available at 0.25°, 0.5°, 1°, 2.5° spatial resolution
- serves background field for all other GPCC products

Full Data Reanalysis V5 Product (1901-2009)

- optimised for spatial density and accuracy for model verification and water cycle analysis
- provides best spatial coverage for the individual months by use of all data available
- the time dependent data coverage varies from 10,000 to 45,000 stations
- Fig. 3 (bottom row) shows El Nino Winter 1997/98
- Fig. 4 shows map and time series of monthly regional precipitation totals in Southern Asia including India and Pakistan (left plot) and Europe (right plot)

2011 HOMPRA 55 Years Data Set (1951-2005)

- A new homogenized precipitation re-analysis data set is scheduled to become available next year

GPCC Product examples: a) First Guess Analysis for August 2010 (total & anomaly)

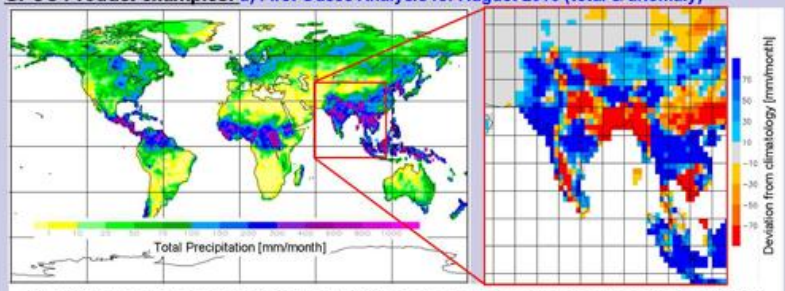


Figure 2: Most recent First Guess Product for August 2010 showing precipitation patterns typical for a La Nina season. The plot is based on approx. 6,500 stations and shows also the strong anomalies across Pakistan on the right hand side anomaly plot.

b) Monitoring and Full Data Product Version 4 for El Nino Winter 1997/98

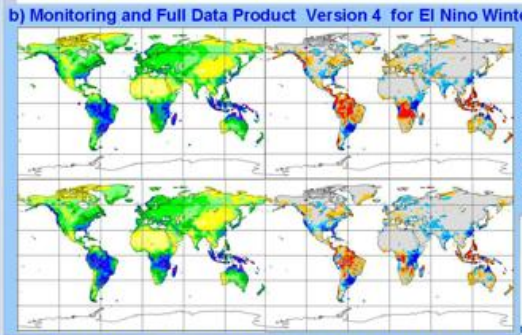


Figure 3: Composite of precipitation totals (left column) and anomalies (right column) for the strong winter 1997/98 El Nino event. The upper row shows the Monitoring Product, available two months after the fact, the lower row the higher resolving Full Data Product, available much later. The comparison demonstrates the reliability of the monitoring product. All plots have been generated via the public accessible 'GPCC Visualizer' web interface (Fig. 5).

Figure 5: Snapshot of the public accessible 'GPCC Visualizer' web interface. Visit http://gpcc.dwd.de to surf the GPCC data base and to generate your own plots along assessments as those shown on this poster!

c) Full Data Product Version 5 based regional monthly totals

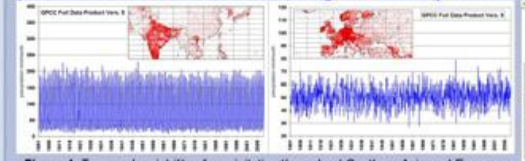


Figure 4: Temporal variability of precipitation throughout Southern Asia and Europe

Global Precipitation Climatology Centre
operated by Deutscher Wetterdienst (DWD), Offenbach - http://gpcc.dwd.de

Figure 11 *Example GPCC poster compiled for the German-Austrian-Swiss Meteorologists Symposium (DACH-MT 2010), 20-24 September 2010 in Bonn, Germany*