



# The new portfolio of global precipitation data products of the Global Precipitation Climatology Centre suitable to assess and quantify the global water cycle and resources

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**Abstract.** Precipitation plays an important role in the global energy and water cycle. Accurate knowledge of precipitation amounts reaching the land surface is of special importance for fresh water assessment and management related to land use, agriculture and hydrology, incl. risk reduction of flood and drought. High interest in long-term precipitation analyses arises from the needs to assess climate change and its impacts on all spatial scales. In this framework, the Global Precipitation Climatology Centre (GPCC) has been established in 1989 on request of the World Meteorological Organization (WMO). It is operated by Deutscher Wetterdienst (DWD, National Meteorological Service of Germany) as a German contribution to the World Climate Research Programme (WCRP). This paper provides information on the most recent update of GPCC's gridded data product portfolio including example use cases.

## 1 GPCC background and agenda

The GPCC collects and assures quality of world-wide observational in-situ data from rain gauges in order to provide gridded high-quality and high-resolution land surface precipitation analyses as mandated by WMO's World Climate Research Program and the Global Climate Observing System (GCOS). Based on over 25 years of operation the GPCC gridded data products are built on base of the world-wide largest archive of quality controlled in-situ precipitation data (Fig. 1). All gridded GPCC data products are public available in OGC compliant netCDF format to the community ([ftp://ftp-anon.dwd.de/pub/data/gpcc/html/download\\_gate.html](ftp://ftp-anon.dwd.de/pub/data/gpcc/html/download_gate.html)).

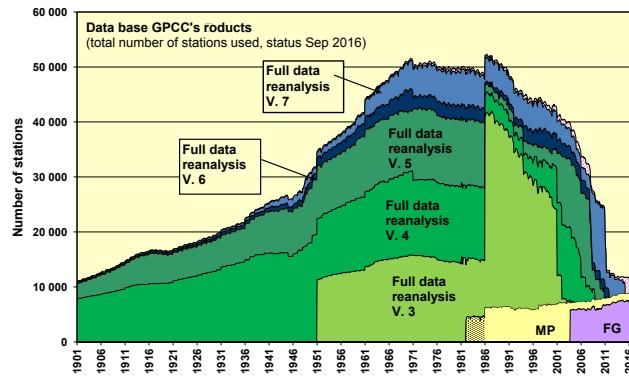
### 1.1 A product portfolio for archetype requirements

Depending on the climate related application and service aspired, there is a large variety of user needs in terms of timeliness, homogeneity, resolution and accuracy which cannot be addressed by one data product. As a consequence GPCC has issued a suite of products that contains near-real-time as well as non-real-time products in monthly and daily resolution

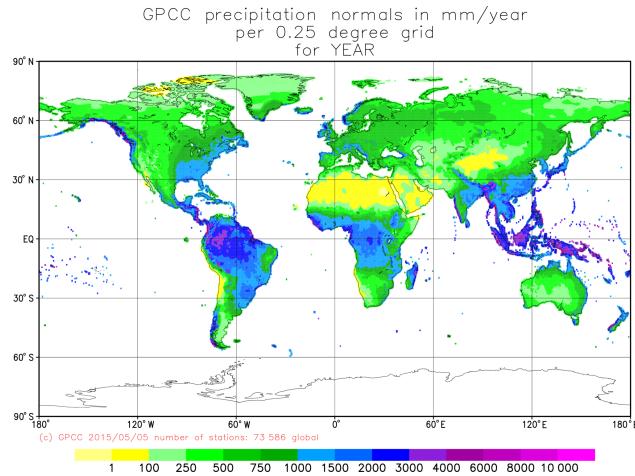
and in spatial resolutions of  $1.0^\circ \times 1.0^\circ$  and  $2.5^\circ \times 2.5^\circ$  (only monthly) latitude by longitude. The non-real-time products based on the complete GPCC monthly rainfall station database (the largest monthly precipitation station database of the world with data from more than 100 000 different stations) are also available in  $0.5^\circ \times 0.5^\circ$  resolution. GPCC's new global precipitation climatology V.2015 (available in  $2.5^\circ \times 2.5^\circ$ ,  $1.0^\circ \times 1.0^\circ$ ,  $0.5^\circ \times 0.5^\circ$ , and  $0.25^\circ \times 0.25^\circ$  resolution, Fig. 2) based on data from the more than 75 000 stations that feature records longer than 10 years of length is used as background climatology for the other GPCC analyses using the anomaly interpolation method also known as climate aided interpolation (CAI).

### 1.2 Data sources of GPCC

Data from national meteorological and hydrological services, regional and global data collections are mainly used to calculate these products, as well as WMO-GTS data. In order to provide the user with a sufficient level of documentation and long term accessibility, GPCC products issued in year 2011 or later are all referenced by digital object identi-



**Figure 1.** Station data coverage of GPCC's near real-time “Monitoring Product” and “First Guess Product” (indicated by “FG”), as well as for the five most recent Versions of the centennial “Full Data Reanalysis with the most recent Version 7” from June 2015.

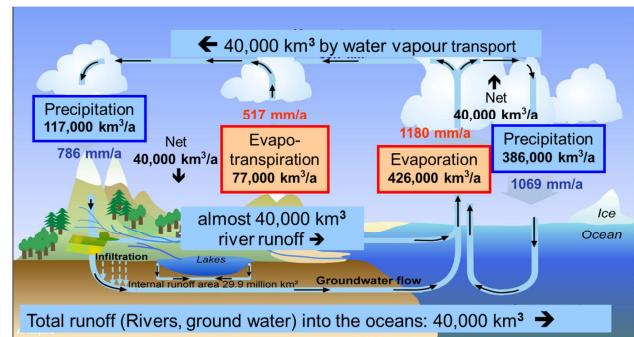


**Figure 2.** GPCC Climatology V2015, annual totals in mm are shown at 0.25° resolution.

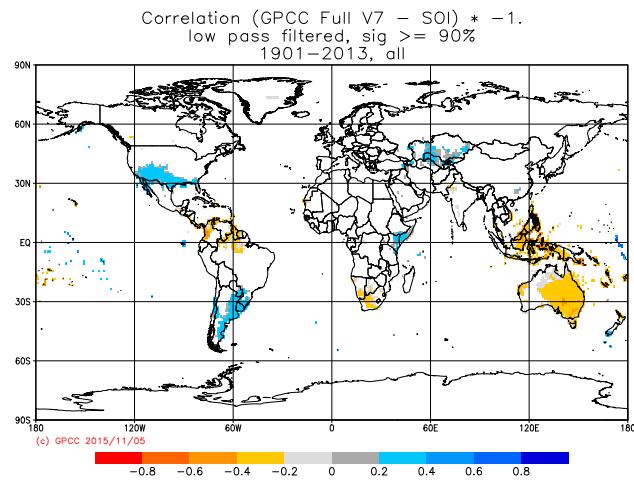
fiers (DOIs, Tables 1 and 2), allowing also for reproducibility and repetition of data utilizations even decades after primary data accesses. Corresponding to international agreements, station data provided by Third Parties are protected. However the gridded GPCC analysis products are freely available via Internet (<http://gpcc.dwd.de>) and GPCC has also issued a test interpolation data set solely based on the public available station data of NOAAs GHCN.

## 2 Most recent versions of monthly data products issued in June 2015

Most recently updated versions of the Full Data Reanalysis (V7) and Climatology (V2015) were released, replacing their predecessors issued in 2011. The updates are enhanced by almost 8000 additional stations that were added to the quality assured data base of the GPCC. Furthermore the data records of existing stations were extended by the most re-



**Figure 3.** Update of the quantitative assessment of the global water cycle utilizing GPCCs land-surface precipitation analysis (Schneider et al., 2014).

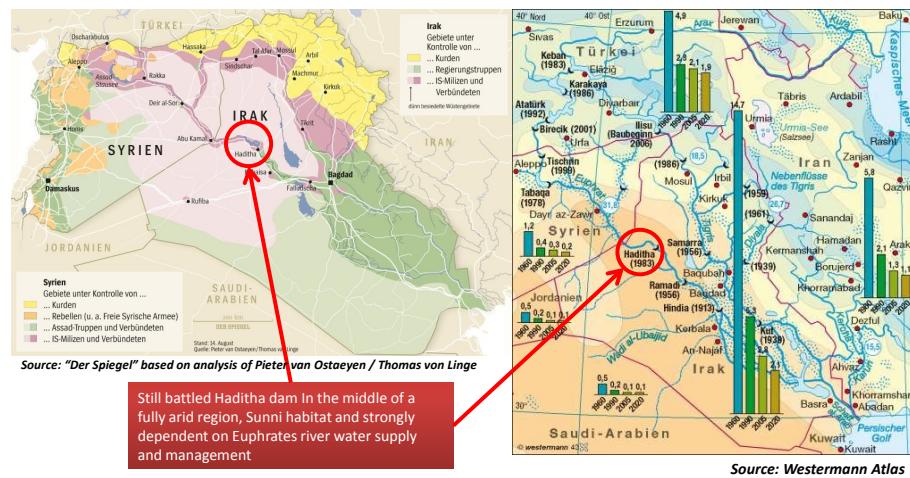


**Figure 4.** Centennial correlation between precipitation (GPCC Full Data Reanalysis V7) for the period 1901–2013 and the negative ENSO Southern Oscillation index ( $-1 \times \text{SOI}$ ) similar to Becker et al. (2013).

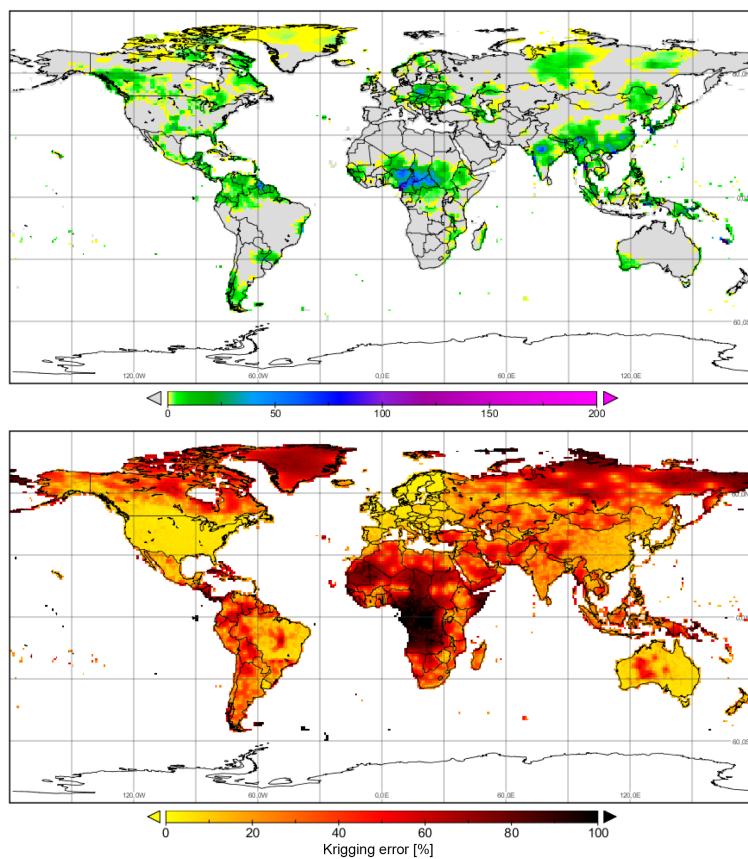
cent years. All in all, the new versions are based on about 75 100 stations with records exceeding 10 years instead of 67 200 stations reprocessed in year 2011. Due to the additional stations and precipitation data, it was possible to detect errors invisible so far and to improve the analysis in particular across Indonesia, Mexico, Brazil and some other regions. Moreover a new land-sea mask has been introduced, adding many grid cells across islands/atolls that had been missing (sea cells) before. The GPCC Full Data Reanalysis Product is the most recommended for quantitative assessments of the global water cycle (Fig. 3) and resources with regard to the precipitation over land (Schneider et al., 2014). It also contains information to understand natural variabilities (Fig. 4) as well as the hydro-climatological background of water related conflicts (Fig. 5). Since July 2015 a first full data daily product (Fig. 6) has been published together with three other new ones (Table 2).

**Table 1.** Overview on monthly data products of the GPCC and their use cases.

Name of GPCC data product			DOI reference for download		
Use cases	Period covered	Time of availability	Regular updates	– Quality – (# of stations) – QC-level	Grid resolution
First guess monthly			doi:10.5676/DWD_GPCC/FG_M_100		
– Near real-time drought monitoring	Oct. 2003 until present	3–5 days after expiry of month regarded	Yes, monthly	– Limited – (6000 to 7600) – Basic (Auto)	Lat–Lon 1.0°
Monthly product V5 (June 2015)			doi:10.5676/DWD_GPCC/MP_M_V5_100 doi:10.5676/DWD_GPCC/MP_M_V5_100		
– Regular HQ monitoring	Jan. 1982 until present	Within two months after end of month regarded	Yes, monthly	– High – (7000 to 8900) – Normal (auto and cross-checks)	Lat–Lon 1.0 and 2.5°
Full data reanalysis V7 (June 2015)			doi:10.5676/DWD_GPCC/FD_M_V7_050 doi:10.5676/DWD_GPCC/FD_M_V7_100 doi:10.5676/DWD_GPCC/FD_M_V7_250		
– Global water cycle and resources	Jan 1901 to Dec 2013	Upon availability of substantially increased data base of quality controlled precipitation data	No, every three to four years	– Best – (11 000 to 51 000 depending on month; 75 100 in total) – High (in-depth screening and correction)	Lat–Lon 0.5, 1.0, and 2.5°
GPCC climatology V2015 (June 2015)			doi:10.5676/DWD_GPCC/CLIM_M_V2015_025 doi:10.5676/DWD_GPCC/CLIM_M_V2015_050 doi:10.5676/DWD_GPCC/CLIM_M_V2015_100 doi:10.5676/DWD_GPCC/CLIM_M_V2015_250		
– Climate aided interpolation (CAI)	Reference period 1951–2000	Similar to full data reanalysis	No, similar to full data reanalysis	– Best – 751 000 – High	Lat–Lon 0.25, 0.5, 1.0, and 2.5°



**Figure 5.** GPCC's climatological data sets are utilized as reference material (right panel, here Westermann Atlas) and potentially help to comprehensively understand water modulated conflicts (left panel) and to serve independent reference information for water diplomacy.



**Figure 6.** Precipitation analysis of 7 July 1997 (top panel) and corresponding interpolation (kriging) error field (bottom panel).

**Table 2.** New GPCC data products issued in July 2015.

Name of GPCC data product			DOI reference for download		
Use cases	Period covered	Time of availability	Regular updates	– Quality – (# of stations) – QC-level	Grid resolution
GPCC interpolation test dataset			doi:10.5676/DWD_GPCC/ITD_M_V1_100 (including monthly station totals of GHCN)		
– Verify GPCC's interpolation method through product based on subset of ~ 23 000 public available NOAA-GHCN stations	Jan–Dec 1988	Similar to full data reanalysis	None	– Test – Up to 24 000 stations – GHCN QC	Lat–Lon 1.0°
GPCC drought index (monthly; Ziese et al., 2014)			doi:10.5676/DWD_GPCC/DI_M_100		
– Drought monitoring	Jan 2013– present expired month	10th of following month	Yes, monthly	– Limited – 6000–7600 – Basic (Auto)	Lat–Lon 1.0°
GPCC first guess daily prod. (Schamm et al., 2014)			doi:10.5676/DWD_GPCC/FG_D_100		
– Early monitoring – Extreme precipitation	Jan 2009– present expired month	4th of following month		– Limited – 6000–7600 – Basic (Auto)	Lat–Lon 1.0°
GPCC full data daily product version 1 (July 2015)			doi:10.5676/DWD_GPCC/FD_D_V1_100		
– Climatological assessment – Climate and weather extremes in precip (WCRP GC and ETCCDI) – Error assessment	Jan 1988– Dec 2013	Upon availability of full data monthly product	No, 1 month after issuance of full data monthly product	– High – (23 000– 30 000) – Auto and vis. check	Lat–Lon 1.0°

### 3 Data availability

All data sets are provided with free and unlimited access through the DOI references provided. Data will be maintained version dependent on the underlying ftp server operated by Deutscher Wetterdienst.

**Acknowledgements.** We are most appreciative to the data suppliers who are to the largest extent the worldwide spread National Meteorological and/or Hydrological Services, but also some other institutes. These data contributions have put Global Precipitation Climatology Centre (GPCC) into the position to provide the global precipitation analyses described in this document, and we are looking forward to their further contributions, which are crucial in order to maintain and enhance GPCC's level of products in terms of scope and quality.

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