The Global Precipitation Climatology Project (GPCP) CDR

Robert Adler
University of Maryland (CICS)
301-405-3206, radler@umd.edu

Matt Sapiano (UMD/CICS), George Huffman (NASA Goddard)
Guojun Gu (UMD), Long Chiu (GMU), Pingping Xie (NOAA/CPC) and others
GPCP Components/People

R. Adler (GPCP Director)

- **Merge Center**—Huffman/Adler, NASA Goddard/U. of Maryland (TOVS/AIRS data from Susskind, Goddard)
- **Gauge Center**—Becker, Schneider, German Weather Service, Global Precipitation Climatology Center (GPCC)
- **Microwave-Land Center**—Ferraro, NOAA NESDIS
- **Microwave-Ocean Center**—Chiu, George Mason U.
- **Geosynchronous Center**—Xie, NOAA/NWS/CPC (also does pentad merge)

*Underlined Names are CO-I’s on this CDR project*
Global Precipitation Climatology Project (GPCP)

GPCP is an international, inter-agency effort under auspices of GEWEX/WCRP to provide CDR-quality global precipitation analyses at monthly, pentad and daily time scales.

**GPCP CDR Objectives**

1) To successfully update, streamline and integrate the GPCP production code for “automated” production,
2) Transfer the routine production of GPCP products to CICS-MD and then to NCDC from the manually driven processing of the Co-Is,
3) Develop an “interim” CDR for GPCP monthly for operational climate analysis
## Project Description

<table>
<thead>
<tr>
<th>CDR(s) (Validated Outputs)</th>
<th>Period of Record</th>
<th>Spatial Resolution; Projection information</th>
<th>Time Step</th>
<th>Data format</th>
<th>Inputs</th>
<th>Uncertainty Estimates (in percent or error)</th>
<th>Collateral Products (unofficial and/or unvalidated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPCP V2.2 Precipitation</td>
<td>1979 - present</td>
<td>2.5 degree global grid</td>
<td>Monthly</td>
<td>NetCDF4</td>
<td>RSS SSMI(S) Tb; Ferraro PMW Land precip; Geo-IR precip (GPI); OPI; Susskind TOVS/AIRS; GPCC Gauge</td>
<td>Error estimates attached to grid; ~10%</td>
<td>Includes interim precip products and errors</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPCP Pentad Precipitation</td>
<td>1979 - present</td>
<td>2.5 degree global grid</td>
<td>5-day mean</td>
<td>NetCDF4</td>
<td>NOAA CPC Pentad Precipitation (CMAP); GPCP V2.2 Monthly</td>
<td>~10%</td>
<td>________</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPCP 1-degree Daily Precipitation</td>
<td>1997 - present</td>
<td>1 degree global grid</td>
<td>Daily</td>
<td>NetCDF4</td>
<td>GPROF SSMI; GPCP V2.2 Monthly</td>
<td>~20%</td>
<td>________</td>
</tr>
</tbody>
</table>
Production approach

- Monthly, Pentad and Daily products produced separately
  - Most inputs are already processed rainfall estimates from other stable sources
  - Different processing is required for 1979-1985, 1986-Jul87 and after Aug87

- CDR code is based on legacy code and is mainly Fortran, with some C and is driven by shell script of Executive Control Program (ECP)
  - Data are output to binary, then combined into a NetCDF file

Diagram of code elements to produce monthly GPCP (1987 to present)
Quality Assurance Approach

- **Input and intermediate file checks**
  - Check the file sizes of the externally-provided data to ensure the integrity of the data transfer
  - Check the files sizes of all intermediate and output data to ensure nominal module completion
  - Examine the output log for standard format error and warning messages from each module (all modules will have a common error/warning reporting syntax)

- **Delivered package will include code for product diagnostics to detect outliers/suspicious results**
  - Generate list of grid locations $> 2\sigma$ from mean
  - Generate monthly ocean, land and total precipitation anomaly time series from the start of the record to assure expected behavior
Applications

With over 1500 journal articles using GPCP data there has been extensive application of the information over a wide range of subjects--a few following examples subject-wise:

Climate Analysis: “Global Climate, Precipitation, in State of the Climate in 2011”. Parker et al., BAMS, 2012 [NOAA/NCDC]


“An Evaluation of Rainfall Frequency and Intensity over the Australian Region in a Global Climate Model” Brown et al., JOURNAL OF CLIMATE 2010

Climate Forecasts:” Challenges for Integrating Seasonal Climate Forecasts in User Applications” Coelho et al., CURRENT OPINION IN ENVIRONMENTAL SUSTAINABILITY 2010.

Applications (cont.)

Health: “Early Warnings of the Potential for Malaria Transmission in Rural Africa” Yamana and Eltahir, MALARIA JOURNAL, 2010


Hydrology: “Floods over the Midwest: A Regional Water Cycle Perspective” Dirmeyer and Kinter, JOURNAL OF HYDROMETEOROLOGY, 2010

Oceans: “Impact of Bathythermograph Temperature Bias Models on an Ocean Reanalysis” Giese et al., JOURNAL OF CLIMATE, 2011

Arctic and Antarctic: “Importance of Deposition Processes in Simulating the Seasonality of the Arctic Black Carbon Aerosol” Huang et al., JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES 2010.


Global Precipitation Climatology Project (GPCP) analyses are often used as a standard or starting point for discussions. GPCP is an analysis based on satellite and gauge data (1979-near present). No TRMM or Cloudsat data are in current GPCP. Current GPCP global long-term number is 2.68 mm/d with an estimated error bar of ~ +/- 7% (Adler et al. 2012 JAMC).

In order to balance global water and/or energy cycle some researchers modify the GPCP number (and other budget component values) to achieve balance, e.g.,

--Trenberth et al. (2009) increase global GPCP number by 5% (within estimated error range)

--Stephens et al. (2012) increase global GPCP number by 15% to achieve balance (unfortunately based on incorrect statements about GPCP)
### Tropical Mean (Ocean) Rainfall Estimates

<table>
<thead>
<tr>
<th>mm/d</th>
<th>TRMM Radar (2A25 NS--adjusted)</th>
<th>TRMM Composite Climatology (TCC)*</th>
<th>GPCP</th>
<th>TRMM PR + CloudSat**</th>
</tr>
</thead>
<tbody>
<tr>
<td>35N-35S (ocean)</td>
<td>2.9</td>
<td>2.9</td>
<td>2.9</td>
<td>3.0 (3 years)</td>
</tr>
<tr>
<td>25N-25S (ocean)</td>
<td>3.2</td>
<td>3.2</td>
<td>3.1</td>
<td></td>
</tr>
</tbody>
</table>

There seems to be a remote sensing consensus emerging of the mean magnitude of tropical ocean rain—this doesn’t mean that this is the correct answer, but that current remote sensing information (TRMM and CloudSat) does not lead to significant “missed rain” in the tropics as claimed by a few.

*Adler et al. 2009 JMSJ  
**Behrangi et al. 2012 JGR
### Global Mean (Ocean) Rainfall Estimates

<table>
<thead>
<tr>
<th>mm/d</th>
<th>GPCP</th>
<th>PR + CloudSat; AMSR + CloudSat*</th>
<th>Trenberth GPCP + 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>60N-60S (ocean)</td>
<td>3.03</td>
<td>3.05*</td>
<td></td>
</tr>
<tr>
<td>Global ocean</td>
<td>2.89</td>
<td></td>
<td>3.06</td>
</tr>
</tbody>
</table>

*Behrangi et al. 2012 JGR

**GPCP global ocean number still seems reasonable, but needs to be examined again with improved data (e.g., GPM, etc.). Global water and energy budget closures require continued careful analysis and improvement of retrievals and analyses.**
“Real-time” (Interim CDR) GPCP Monthly Product

- **GPCP updates occur ~2 months after end of month**
  - Latency due to GPCC research-quality gauge analysis
- **Goal for interim product is 10 days after end of month**
  - Use GPCC First Guess gauge analysis product (~10 days) and all satellite datasets (therefore dependent on timely RSS and CPC inputs)
  - Below is an example for Jan 2008
  - Plan to test over next few months and start production Jan. 2014

---

**GPCP precip, Jan 2008**

**Near real-time precip, Jan 2008**
**GPCP CDR status**

- **Integrated code to produce GPCP V2 monthly from 1979-present running at UMD/CICS**
  - Code is in a mature state, with configure files etc., and has been transitioned to other machines (incl. at GSFC)
  - Currently experiencing delays in processing caused by AIRS data availability (AIRS just released V6 data). All GPCP Processing paused at Feb 2013.
  - Data now being output in NetCDF4 format

- **Draft C-ATBD for monthly product completed and ready for comment**
Schedule and Milestones

- GPCP Monthly will be run (with automated software) at UMD/CICS and compared to old, non-automated processing during Sep.-Dec. 2013. QA Diagnostics for Monthly product will be implemented in parallel. UMD/CICS will then be prime source of GPCP Monthly for NCDC (January 2014).

- Interim GPCP Monthly CDR will be tested Sep.-Dec. 2013; available for use in January 2014

- Pentad GPCP - working with Pingping Xie (CPC) to transition code to UMD and integrate into automated system code implemented, tested (with diagnostics) (June 2014)

- Daily GPCP: transition started; will follow template of monthly product
  - This is complicated task, the first step of which is implementing GPROF V2004 [Jan 2014] then producing CDR code to do the data merge [first integrated version by September 2014]
Issues

- SSMIS data: GPCP monthly product uses RSS SSMIS Tb. Lack of RSS data at NCDC will delay testing and production.

- Input changes: changes in algorithms, instruments, etc. require expertise and rapid response to keep quality products being produced.
  - Recent example: New AIRS V6 data requires re-calibration before it can be used in GPCP – requires expertise from UMD/NASA group; another example—change in gauge analysis requires re-processing of entire record.
GPCP Plans for Future Products

- As part of GEWEX re-processing of all global water/energy data sets (e.g., ISCCP, SeaFlux), GPCP group developing **next version (Version 3)** of GPCP
  - New input data sets (e.g., TRMM, AMSR), higher time and space resolutions (down to 3-hr and 25 km for part of period).
  - Link to NASA/NOAA GPM activities
  - New groups (e.g., CSU, UCI) involved
  - Rain/snow discrimination (by temperature)
  - CDR standards for science and coding