CDR DEVELOPMENT PROJECT

The Global Precipitation Climatology Project (GPCP) CDR

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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)

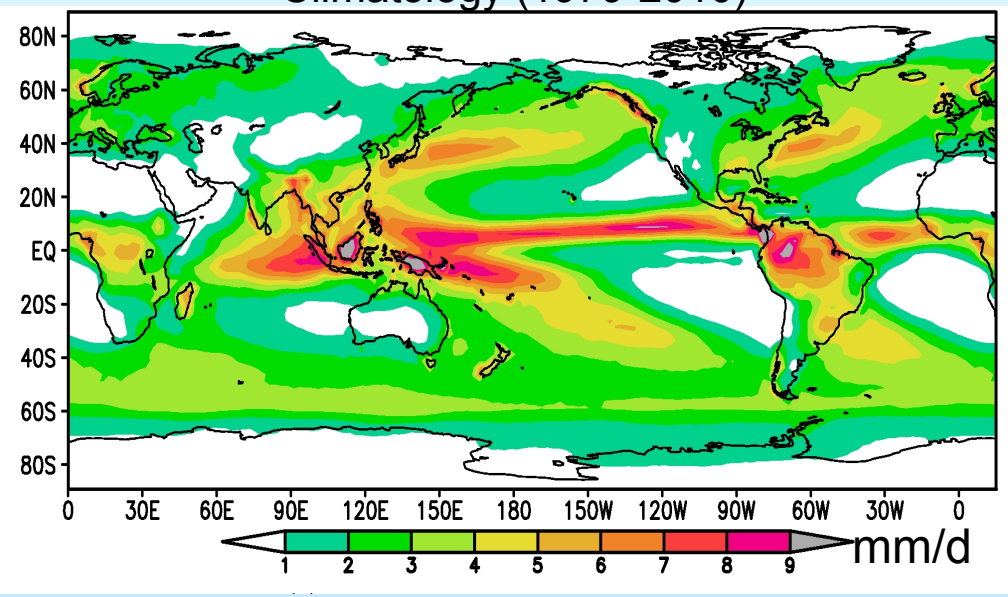
Underlined Names are CO-I's on this CDR project

Project Description

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.

Climatology (1979-2010)



GPCP data used in > 1500 journal articles

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

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

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

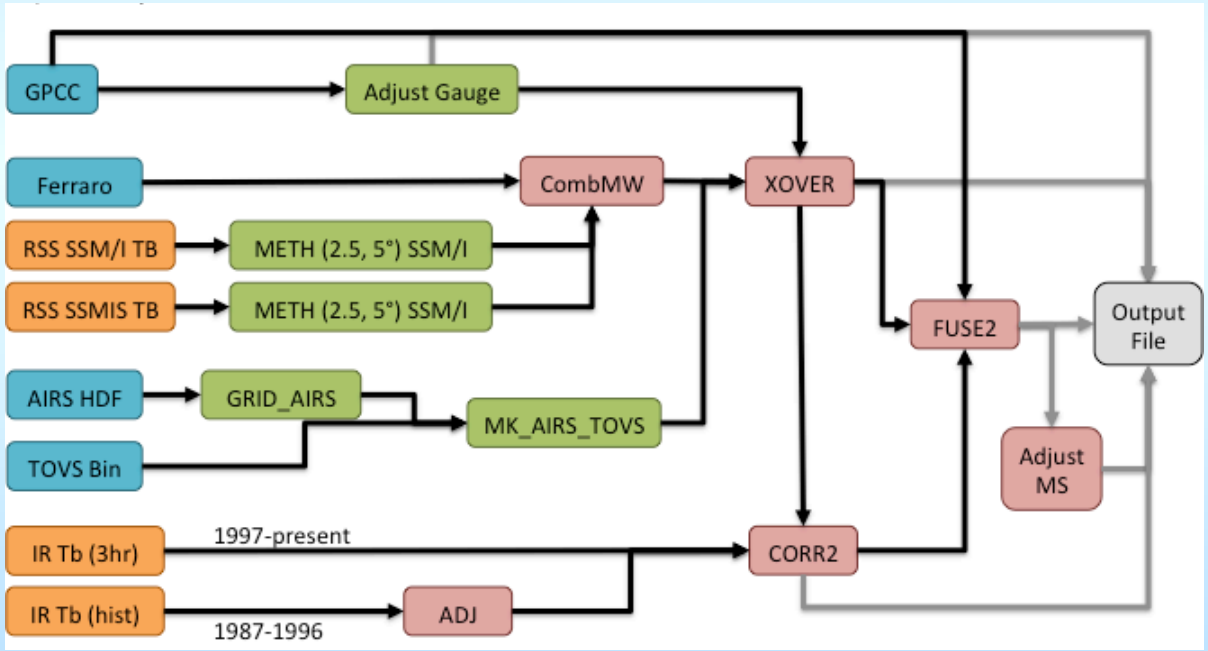


Diagram of code elements to produce monthly GPCP (1987 to present)

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 > 2σ 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]

Global model validation: "MERRA: NASA's Modern-Era Retrospective Analysis for Research and Applications" , Michele Rienecker et al. JOURNAL OF CLIMATE 3624-3648, 2011.

"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.

Government and Economics: "Economic Shocks and Civil Conflict: An Instrumental Variables Approach", Miguel et al., JOURNAL OF POLITICAL ECONOMY, 2004

Applications (cont.)

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

Agriculture: "Analysis of Vegetation Response to Rainfall with Satellite Images", Jiang et al., JOURNAL OF GEOGRAPHICAL SCIENCES , 2011

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.

Upper Atmosphere: "Impact of Polar Ozone Depletion on Subtropical Precipitation" Kang et al., SCIENCE 2011.

Climate, Radiation and Water Cycle: "An Update on Earth's Energy Balance in Light of the Latest Observations", G. Stephens et al., NATURE GEOSCIENCE 2012

Absolute Magnitude of Global Precipitation

Global Precipitation Climatology Project (GPCP) analyses are often used as a standard or starting point for discussions. GPCP is an analysis based 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

mm/d	TRMM Radar (2A25 NS--adjusted)	TRMM Composite Climatology (TCC)*	GPCP	TRMM PR + CloudSat**
35N-35S (ocean)	2.9	2.9	2.9	3.0 (3 years)
25N-25S (ocean)	3.2	3.2	3.1	

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

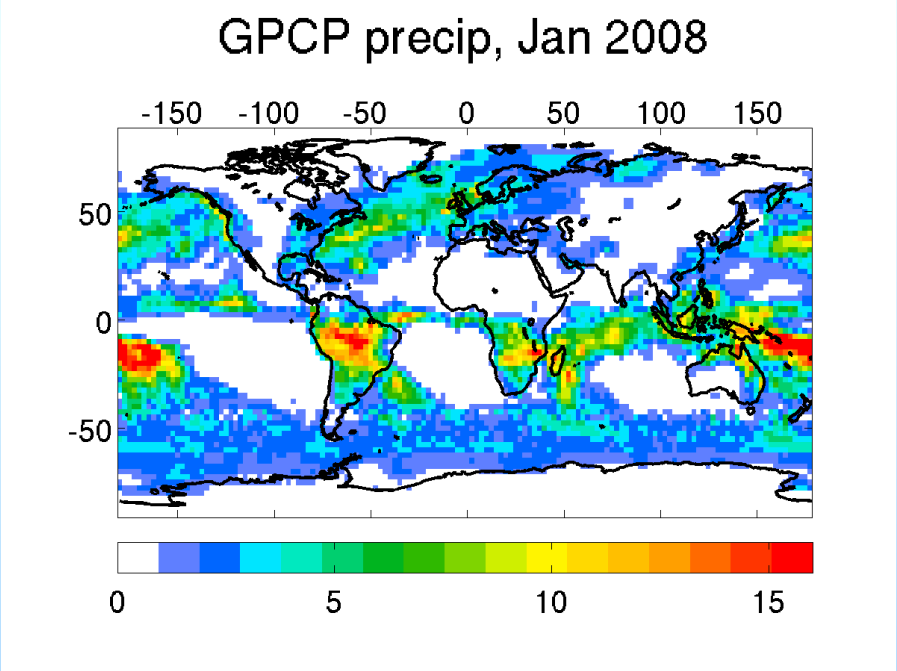
mm/d	GPCP	PR + CloudSat; AMSR + CloudSat*	Trenberth GPCP + 5%
60N-60S (ocean)	3.03	3.05*	
Global ocean	2.89		3.06

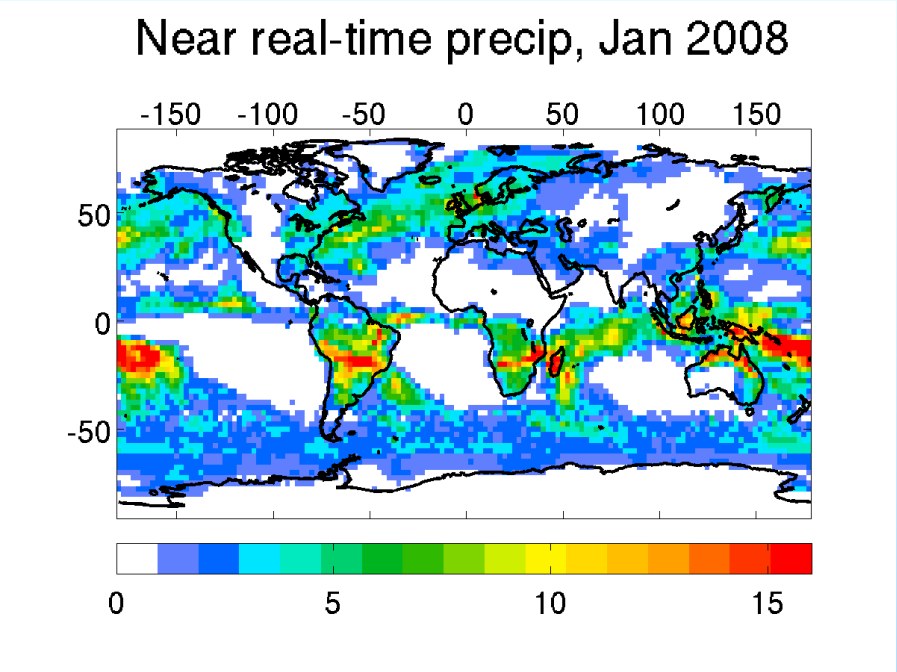
*Behrangi et al. 2012 JGR

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 is10 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 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