GPCP Version 3.2 Products and Results

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INTRODUCTION

The Global Precipitation Climatology Project (GPCP) products address the need for long-term precipitation products that emphasize homogeneity, following Climate Data Record (CDR) principles. Version 3.2 is the latest successor to both Version 2.3 Monthly and 1.3 Daily.

BUILDING THE NEW GPCP V3 *MONTHLY* DATASET

Summary of Upgrades from V2.3 Monthly to V3.2
- spatial grid shifted from 2.5° to 0.5°
- consistent GEO-IR Tb datasets, expand area of use from 40°N-S to 58°N-S
- upgraded PMW (GPROF) and IR (PERSIANN-CDR) algorithms
- consistent AIRS-IR record
- shifted AIRS-to-TOVS calibration to improved TOVS-to-AIRS-IR
- added modern climatological calibrators (TCC over 20°N-S, MCTG outside 35°N-S, blended cross-over in between)
- new data fields: probability of liquid phase, Gauge Relative Weighting, Quality Index
- substitute climatological Fuchs gauge undercatch coefficients for Legates-Wilmott over Eurasia above 45°N

To provide a CDR-like data set, we still prioritize
- consistent inputs
- careful inter-sensor calibration
- consistent processing over the entire record

BUILDING THE NEW GPCP V3 *DAILY* DATASET

The inputs are:
- Integrated Multi-satellitE Retrievals for GPM (IMERG)
- TOVS, AIRS-IR daily: Susskind cloud volume algorithm
- GPCP V3.2 Monthly

Approach:
- average IMERG Final (originally 0.1°, ½ hr) up to 0.5° daily
- histogram-calibrate TOVS, AIRS-IR to IMERG
- use IMERG in the band 55°N-S and IMERG-calibrated TOVS/AIRS at higher latitudes
  - this is done for simplicity; future versions will use IMERG over more latitudes
- "feather" the IMERG-AIRS difference just outside 55° to reduce seams
- scale the Daily to (approximately) sum to the Monthly product
- compute daily average of precipitation-weighted probability of liquid phase

Period of record is June 2000 – September 2021 (currently)

(a) MONTHLY, (b) DAILY DATA FIELDS IN V3.2

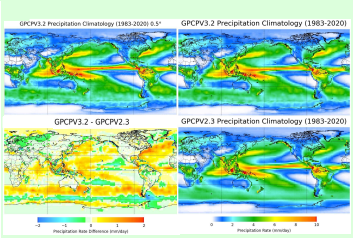
a Monthly Data Field	Units/Indexing
merged satellite-gauge precipitation estimate	mm/d
merged satellite-gauge precipitation random error estimate	mm/d
satellite-only precipitation estimate	mm/d
satellite source field	IR = 0, IR/TOVS/AIRS blend = 2, TOVS/AIRS = 4
undercatch-corrected gauge analysis precipitation	mm/d
probability of liquid phase	%
gauge relative weighting	
quality index	
b Daily Data Field	**Units**
merged satellite-gauge precipitation estimate	mm/d
probability of liquid phase	%

V3.2 CLIMATOLOGY STUDIES

Gauges tend to dominate land areas in both V2.3 and V3.2
- decrease in northern Eurasia due to Fuchs correction

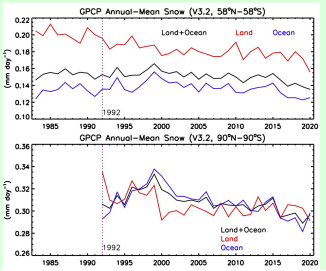
V3.2 tends to be higher over oceans
- largest increases in storm tracks
- decrease around 60°S in V3.2 improves a perceived V2.3 issue
- increase in polar regions driven by CloudSat (in MCTG)

Full-resolution V3.2 (top left) has artifacts due to the IR in the Indian and Atlantic Oceans



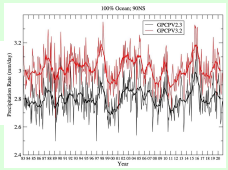
Comparison of V3.2 and V2.3 for mean precipitation rate (mm/day) (1983-2020)
- global increase approximates recommendation of data assessment studies

GPCP	Ocean			Land			Global		
	V3.2	V2.3	% change compared to V2.3	V3.2	V2.3	% change compared to V2.3	V3.2	V2.3	% change compared to V2.3
25°N-25°S	3.35	3.17	5.68	3.45	3.47	-0.58	3.38	3.25	4.00
60°N-60°S	3.26	3.05	6.89	2.52	2.54	-0.79	3.05	2.90	5.17
90°N-90°S	3.09	2.90	6.55	2.21	2.24	-1.34	2.81	2.69	4.46

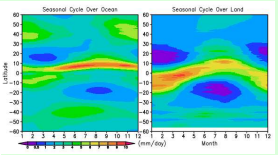


Time series of the global-average estimated snowfall for (top) 58°N-S (1983-2020), and (bottom) 90°N-S (1992-2020, due to dataset limitations)
- general downward trend over land, as expected due to global warming
- oceans increase to 2000, then decrease
- land shows a downward shift at 2000 when the polar regions are included (bottom)
- the V3.2 Daily shows the same trending (starting in mid-2000, of course), but with lower average rates

Time series variations in V3.2 and V2.3 global ocean average largely match
- interannual variation in the tropics is governed by METH in both
- calibration by TCC and MCTG sets the mean increase in V3.2

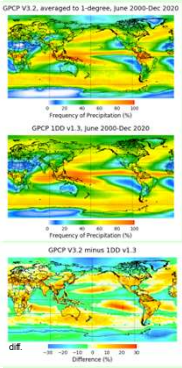


Seasonal variations in zonal means for V3.2
- The Ocean ITCZ rests slightly above the Equator and peaks during boreal summer and tropical cyclone season
- A second, weaker maximum at 5-10°S during March-April combines the SPCZ and the southern portion of the (transient) eastern Pacific double ITCZ
- The mid-latitude features are most intense in the respective winters.
- The land ITCZ latitude (Africa and South America) varies more strongly than over ocean
- The secondary peak at 20°N in boreal summer, relates to the Asian monsoon
- Mid-latitude features are less distinct, especially in the Northern Hemisphere

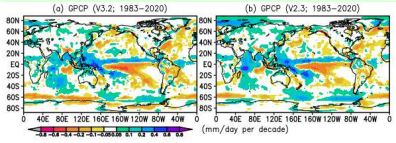


Daily product frequencies of occurrence differ
- V3.2 averaged to 1° to match V1.3 resolution
- V3.2 higher(lower) over ocean for lower(higher) values
- V3.2 mostly higher over land
- V3.2 lower in polar regions

Algorithm differences matter
- IMERG has 48 samples/day, V1.3 IR has 8, TOVS/AIRS has 2-4
- both V3.2, V1.3 use daily (somewhat different) TOVS/AIRS in "high latitudes" with occurrence calibrated to the "low latitudes" at a mid-latitude point
  - the low latitude edge is 55°(40°)N,S for V3.2(V1.3)
  - both are highly approximate
  - AVHRR-based retrievals will be considered



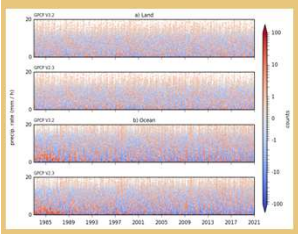
V3.2 trend pattern and magnitude are very close to V2.3 trends, but subtle differences exist
- Near-zero global trend, but significant regional trends
- ITCZ, W. Pacific, Indian Ocean increase; S. Pacific and mid-latitude storm tracks decrease



LOOKING AT EXTREMES WITH HATS

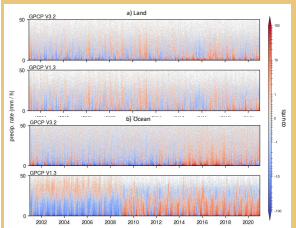
The recently developed Histogram Anomaly Time Series (HATS) analysis (Potter et al. 2020) allows us to examine the aggregate time behavior of the GPCP products, here covering 30°N-S.
- each month's or day's histogram of gridbox values in the latitude band is plotted as a column, then the grand average month-by-month seasonal cycle is computed for each precipitation rate bin and subtracted from the time series.
- the resulting anomalies demonstrate times and rates for which there are fewer or more events (blue and red, respectively) than is typical for each precipitation rate bin's seasonal cycle
- the color table is logarithmic (except being linear over [-1,+1] to give reasonable behavior near zero) to accommodate the skewed distributions

Monthly HATS
- land and ocean variations in both GPCP versions are rather similar despite the algorithmic and spatial resolution differences
  - this builds confidence in the results
  - the heavier blues near zero and reds above that in both versions for ocean before about 1988 appear when both versions use a climatological PMW calibration
  - however, V2.3 switches to a month-by-month PMW calibration in late 1987, but V3.2 uses the climatological calibration until January 1992, and the two diagrams continue to be very similar during that time interval, so additional study is required
- despite noisiness in the diagrams
  - strong El Niños during 1997-1998 and 2015-2016 are associated with positive (negative) anomalies in heavy rates over the ocean (land), as expected, and
  - vice-versa for La Niñas during 1998-2001 and 2010-2012



Daily HATS (with 35-day "monthly" polynomial filter and different time scale)
- variations in both GPCP versions are rather similar over land despite the algorithmic and spatial resolution differences
  - this builds confidence in the results
  - but, the oceanic HATS shows abrupt and persistent changes
  - V1.3 shifts in January 2009 when the calibrator went from the F13 SSMI to the F17 SSMIS
  - V3.2 shifts in June 2014 when the IMERG calibrator shifted from TRMM to GPM
- the monthly calibration corrects the mean precipitation in each month using a simple ratio, but does not change the relative daily values

Mentally filtering out the June 2014 shift in ocean anomalies, the 2015-2016 El Niño is associated with positive (negative) anomalies over the ocean (land), as expected



FINAL COMMENTS, UPCOMING WORK, AND ACKNOWLEDGMENTS

GPCP Version 3.2 is designed for
- new satellite retrievals
- higher user expectations
- upgrades in dataset formats and archiving
- continued CDR standards
- consistency: submonthly (approximately) add up to the monthly values

Paper in review

Huffman, G.J., R.F. Adler, A. Behrangi, D.T. Bolvin, E.J. Nelkin, G. Gu, M.R. Ehsani, 2023: The New Version 3.2 Global Precipitation Climatology Project (GPCP) Monthly and Daily Precipitation Products. *J. of Climate*, in revision.

GPCP has been funded for 5 more years under the 2022 MEaSUREs program, and will focus on:
- consistency and accuracy, by improving satellite and gauge analyses
- extending Daily back to 1983
- shifting to 0.1° resolution (from 0.5° in GPCP V3.2)
- shifting to 2-week latency using UCSB Climate Hazards Center (CHC) gauge analyses

Monthly and daily datasets are posted at GES DISC
- V3.2 monthly DOI: *10.5067/MEASURES/GPCP/DATA304*
- V3.2 daily DOI: *10.5067/MEASURES/GPCP/DATA305*
- landing pages give access to data and documentation
- interactive analysis available through *https://giovanni.gsfc.nasa.gov/giovanni/*

Acknowledgments

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