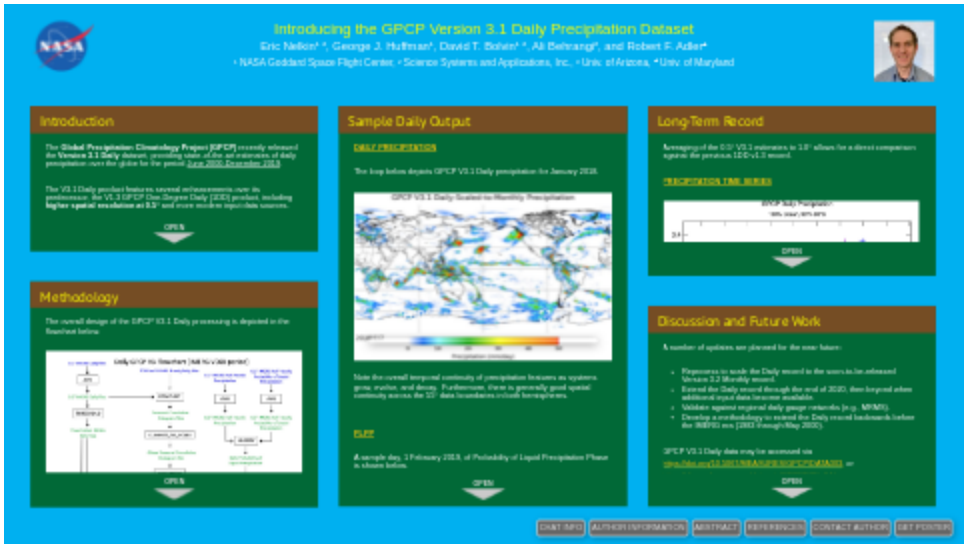
Introducing the GPCP Version 3.1 Daily Precipitation Dataset



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PRESENTED AT:

INTRODUCTION

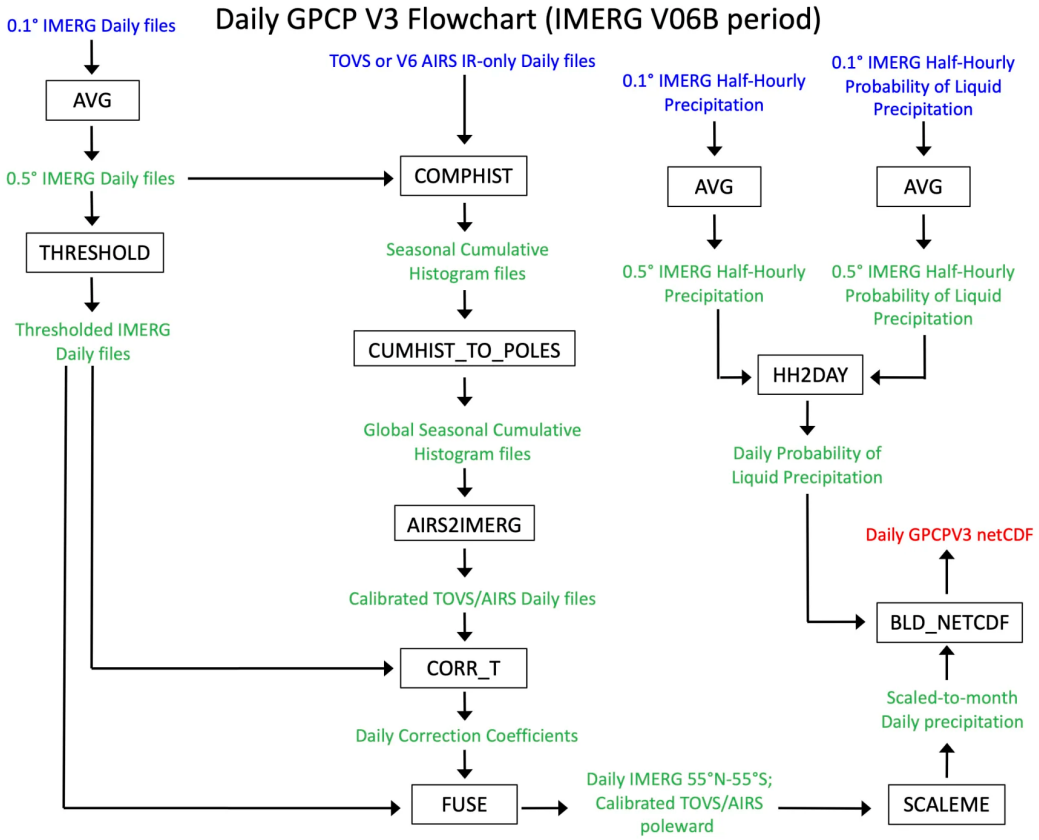
The **Global Precipitation Climatology Project (GPCP)** recently released the **Version 3.1 Daily** dataset, providing state-of-the-art estimates of daily precipitation over the globe for the period June 2000-December 2019.

The V3.1 Daily product features several enhancements over its predecessor, the V1.3 GPCP One-Degree Daily (1DD) product, including **higher spatial resolution at 0.5°** and more modern input data sources.

The daily precipitation estimates are calibrated to the V3.1 Monthly to control bias and create a consistent downscaling of the Monthly. In addition to precipitation, the V3.1 Daily also includes daily gridded estimates of **probability of liquid precipitation phase**, using the same scheme developed for the Integrated Multi-satellitE Retrievals for the Global Precipitation Measurement (GPM) mission (IMERG).

METHODOLOGY

The overall design of the GPCP V3.1 Daily processing is depicted in the flowchart below.



Construction of the global **precipitation** daily map involves stitching together estimates from distinct latitude bands:

- **Within the region 55°N-55°S,** the V3.1 Daily is based on the half-hourly IMERG V06B Final Run aggregated to the daily scale.
- **In the regions 90°N-55°N and 55°S-90°S**, the V3.1 Daily consists of an intercalibrated record of TOVS and AIRS precipitation estimates, which in turn is calibrated to IMERG.
- **Near 55°N and 55°S**, an empirically developed “feathering” technique is used to minimize discontinuities at the boundaries between the IMERG and TOVS/AIRS domains.

Probability of Liquid Precipitation Phase (PLPP) is computed based on MERRA-2 analyses of surface temperature, humidity, and pressure using a diagnostic lookup table developed by Sims and Liu (2015). Following Sims and Liu, the not-liquid precipitation class is “solid” (snow, graupel, etc.), while the relatively rare “mixed” precipitation class (both liquid and solid in a single observation) is included in “liquid”, since mixed is presumed to generally melt and therefore be a liquid. At the daily scale, the PLPP is computed as

the fraction of the daily accumulation that fell as liquid.

Because it is computed from ancillary data, PLPP is always a globally-complete field, even in locations where the precipitation value is zero.

PLPP daily maps are constructed as follows:

- **In the IMERG zone**, PLPP is computed as the precipitation-rate-weighted average of all half-hourly probabilities in the day, except:
- **Where zero precipitation is estimated for the day,** it is the simple average of all available probabilities in the day.
- **In the TOVS/AIRS regions**, the daily PLPP is the simple average of the 48 half-hourly PLPP in the day.

The final step combines the scaled-to-month daily precipitation values and the corresponding daily PLPP values into a Daily V3.1 file in netCDF format.

SAMPLE DAILY OUTPUT

DAILY PRECIPITATION

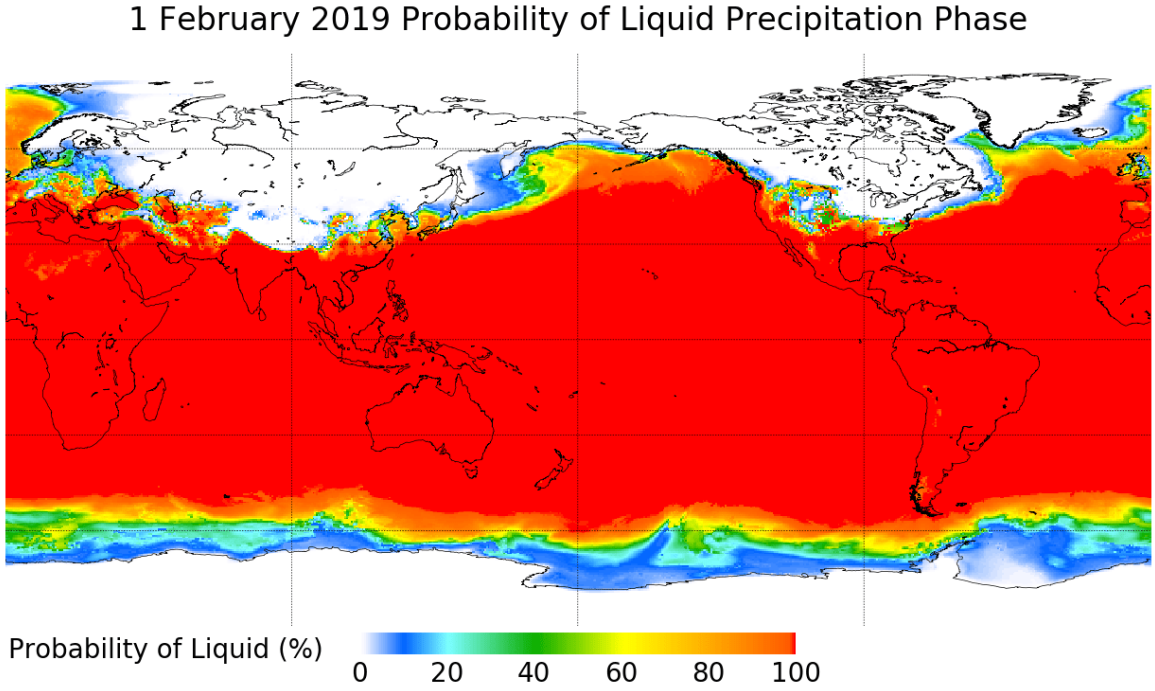
The loop below depicts GPCP V3.1 Daily precipitation for January 2018.

[VIDEO] https://res.cloudinary.com/amuze-interactive/video/upload/vc_auto/v1638312344/agu-fm2021/63-E3-57-ED-B3-F1-75-9D-AB-03-6D-97-37-16-7D-B2/Video/GPCPV3.1.scaled_to_monthly.201801_jc16mk.mp4

Note the overall temporal continuity of precipitation features as systems grow, evolve, and decay. Furthermore, there is generally good spatial continuity across the 55° data boundaries in both hemispheres.

PLPP

A sample day, 1 February 2019, of Probability of Liquid Precipitation Phase is shown below.

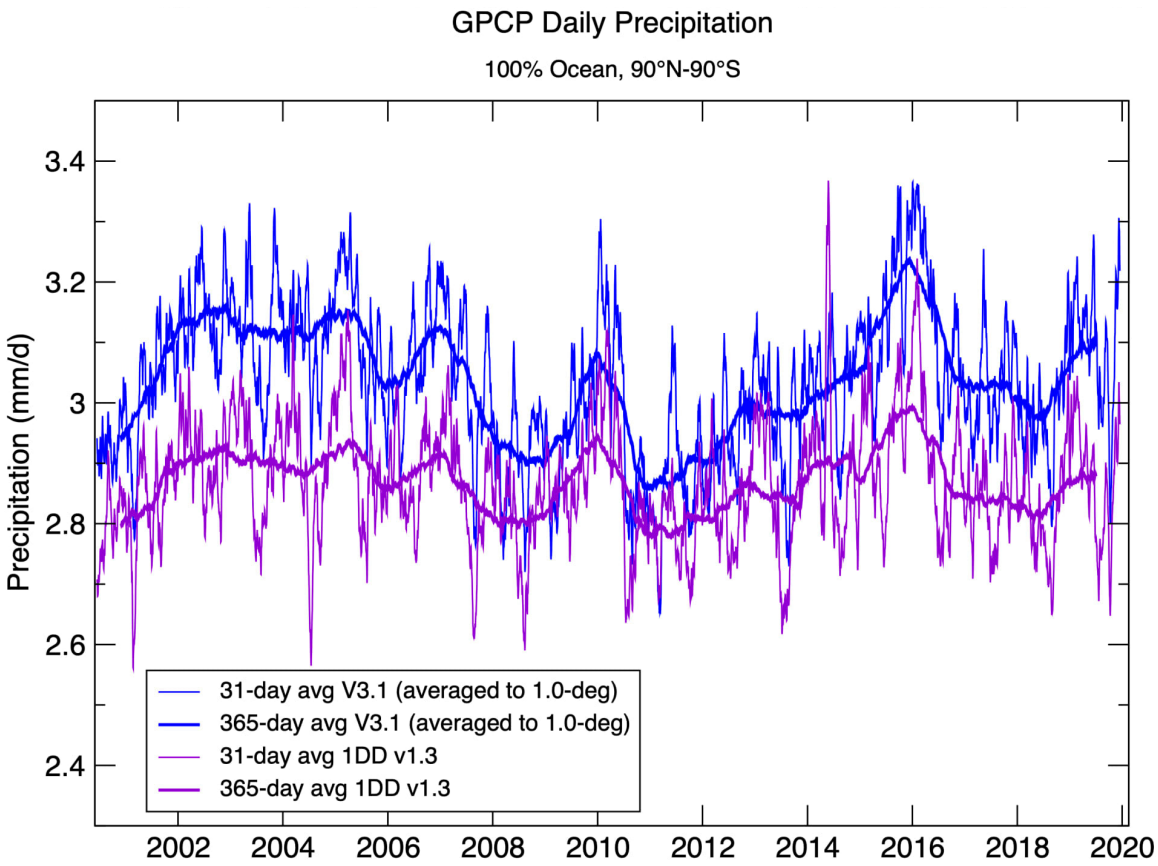


PLPP exhibits 0% values (i.e., frozen precipitation) over vast areas of Northern Hemisphere land, as expected during the heart of winter. Nearly all of the Antarctic continent features 0% values as well. At the other extreme, 100% values dominate the tropics and subtropical oceans. Large gradients are found across land areas in Europe, Asia, and North America, and in the high-latitude oceans.

LONG-TERM RECORD

Averaging of the 0.5° V3.1 estimates to 1.0° allows for a direct comparison against the previous 1DD v1.3 record.

PRECIPITATION TIME SERIES



The global time series of 0.5° grid boxes classified as 100% ocean is shown above. Thinner (thicker) lines depict a 31-day (365-day) running average.

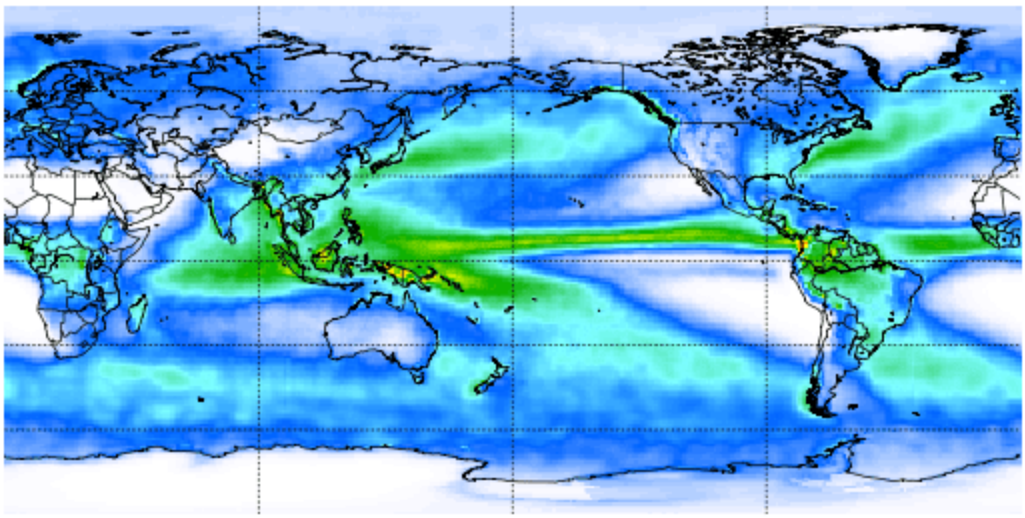
In general, the two products track well together. The V3.1 is consistently higher than 1DD by ~0.2 mm/day. This is a reflection of differences in calibration. No discernible long-term trend is evident in either product.

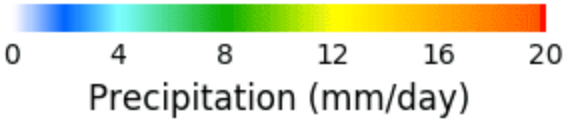
PRECIPITATION COMPOSITES: AMOUNT

Global composite maps covering the entire 19.5-year record are depicted below for GPCP V3.1 (top), 1DD

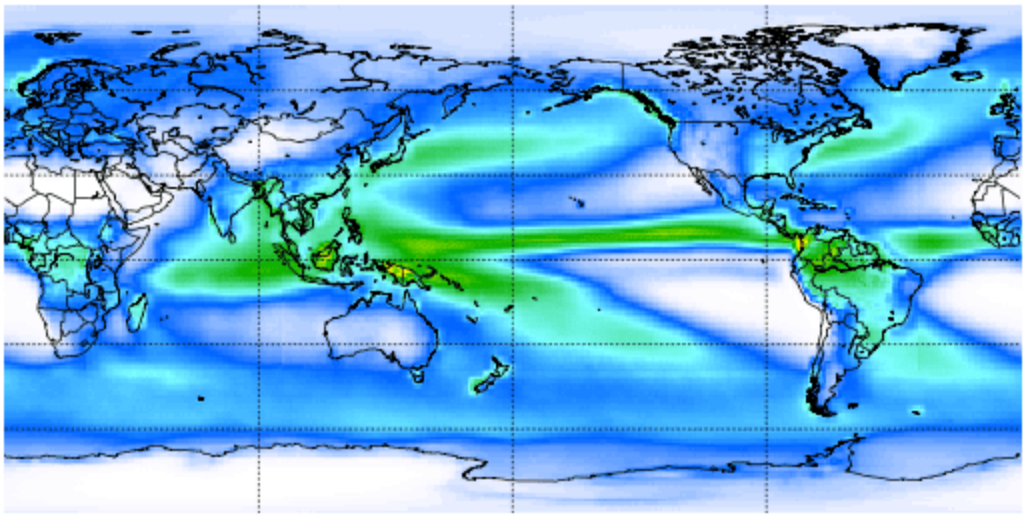
v1.3 (middle), and the difference.

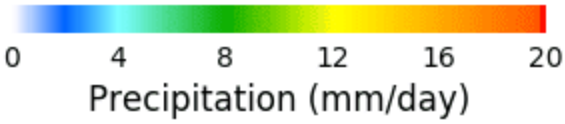
GPCP V3.1, averaged to 1-degree, June 2000-Dec 2019



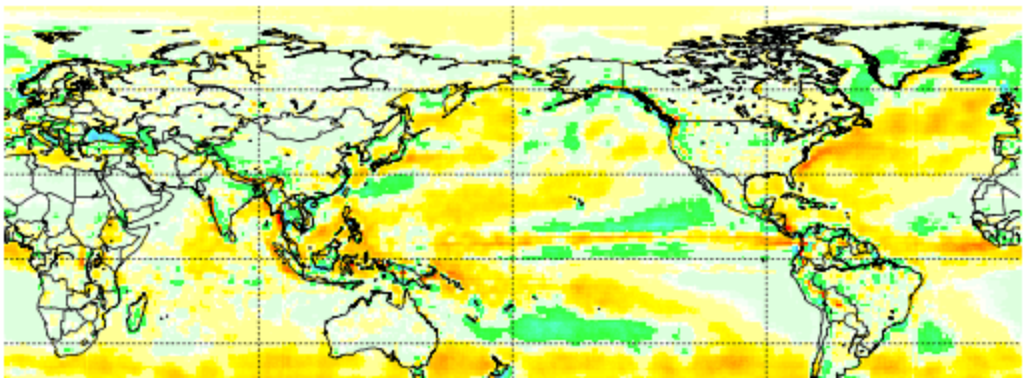


GPCP 1DD v1.3, June 2000-Dec 2019





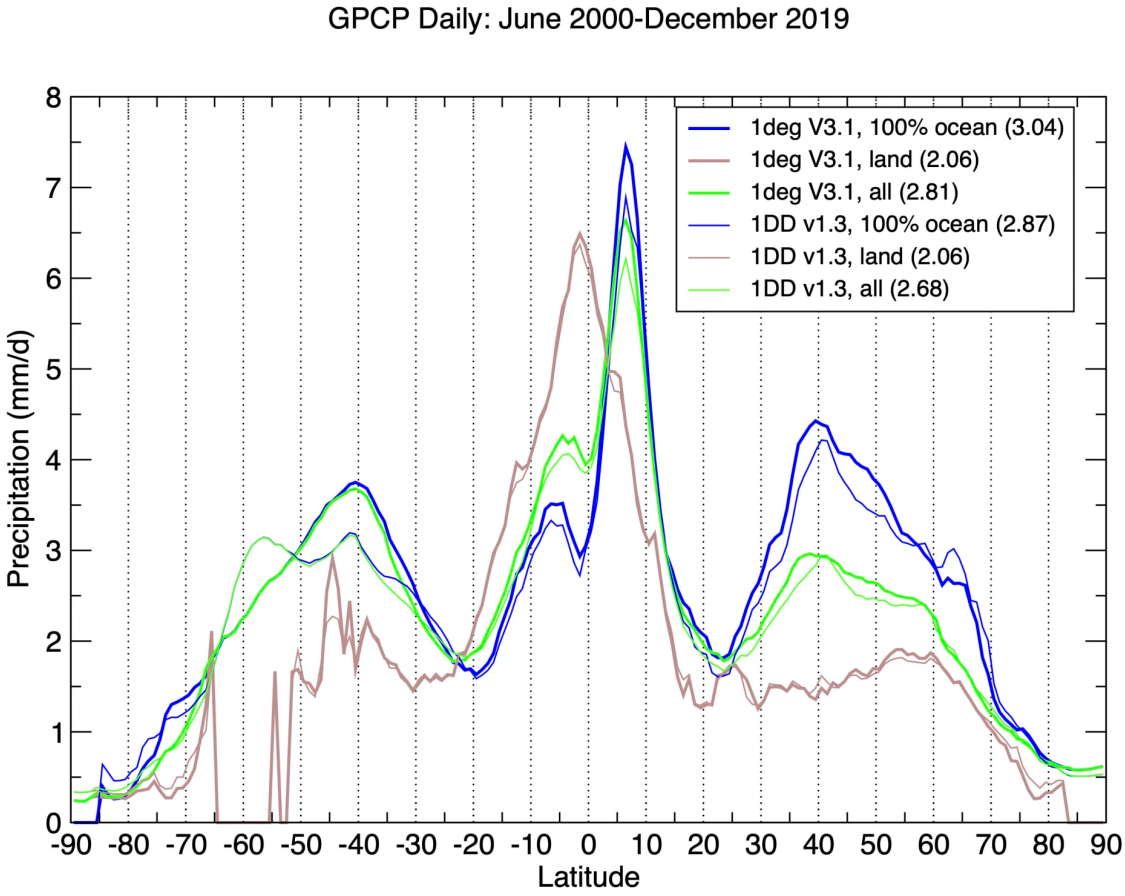
GPCP V3.1 minus 1DD v1.3



Difference (mm/day)

Differences are largely confined to the range -1.5 to +1.5 mm/day. V3.1 shows an enhancement of precipitation in the Gulf Stream extending northeastward across the North Atlantic, as well as increases in the heart of the ITCZ in both the Pacific and Atlantic. Differences over land tend to be smaller than over ocean due to the heavy influence of gauges in both datasets.

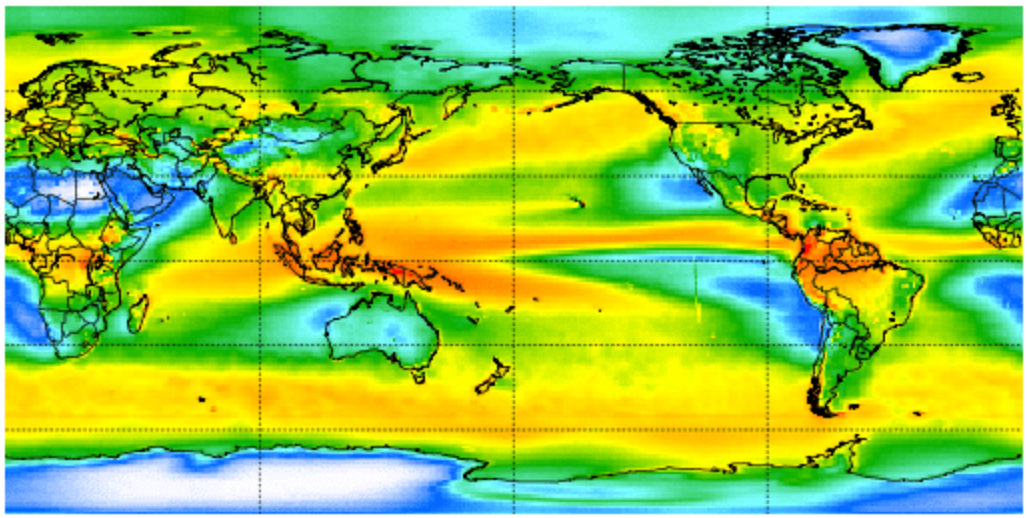
In the Southern Ocean, the difference map reveals bands of opposite signs. V3.1 is generally higher over ~30°-50°S, while 1DD is higher from ~50°-65°S, and V3.1 is higher along much of the Antarctic coast. These tendencies can be seen in the zonal profiles (below), where the thicker (thinner) lines represent V3.1 (1DD), and differences are stratified by surface type.



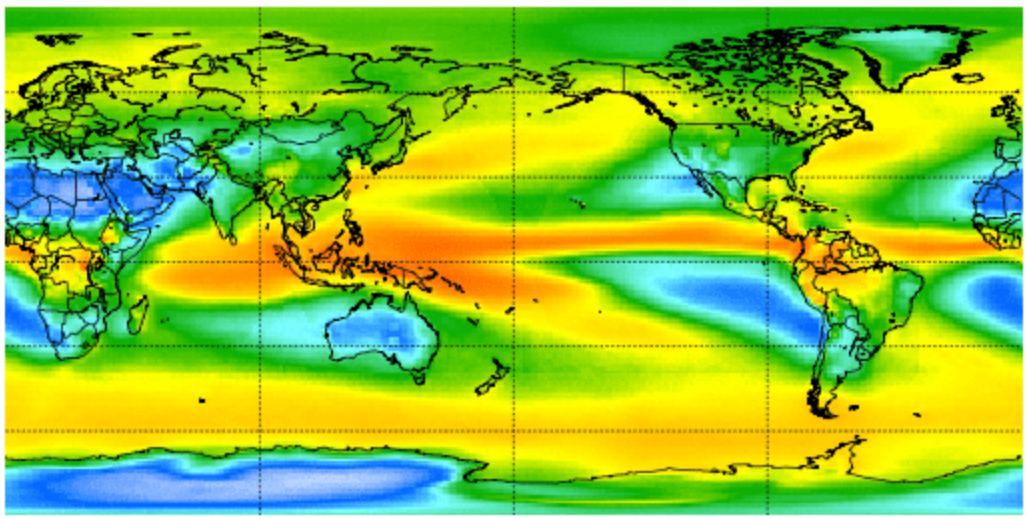
PRECIPITATION COMPOSITES: FREQUENCY

A similar analysis was done to compare the frequency of occurrence of precipitation between the two products.

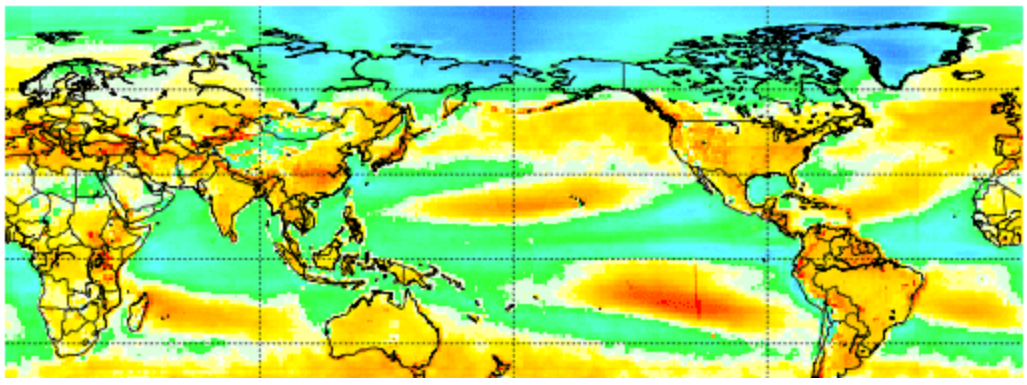
GPCP V3.1, averaged to 1-degree, June 2000-Dec 2019



GPCP 1DD v1.3, June 2000-Dec 2019



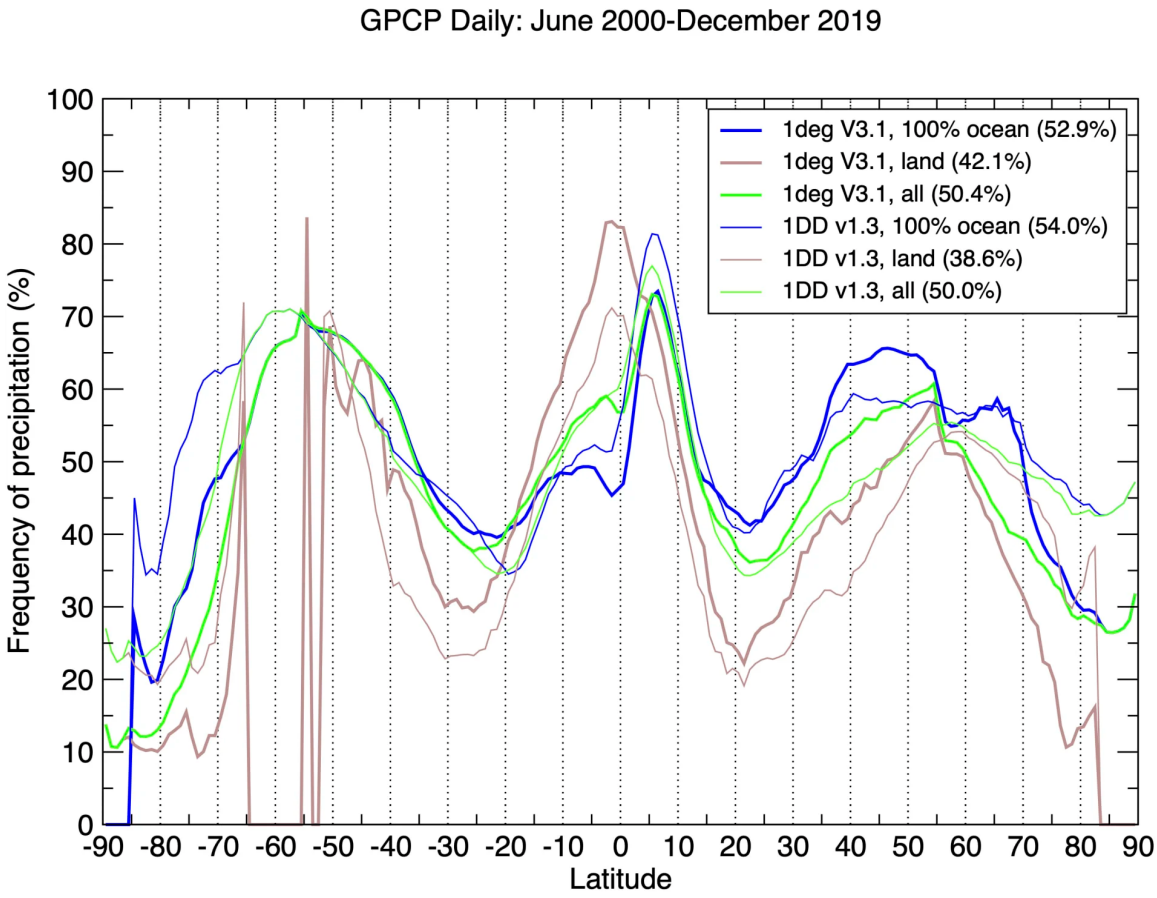
GPCP V3.1 minus 1DD v1.3



Difference (%)

Perhaps most notable are portions of the Arctic and Southern Oceans, where precipitation is up to 30% less frequent in V3.1. This is likely a more realistic depiction, as 1DD tended towards zonal homogeneity in these latitude bands. Further, V3.1 incorporates scaling by the Merged CloudSat, TRMM, and GPM (MCTG) product when calibrating the Daily to the V3.1 Monthly.

The V3.1 Daily frequency of occurrence is consistenly higher than 1DD over nearly all land and over the oceanic dry zones. This may be due to differences in detection skill in the underlying algorithms. Sampling differences (e.g., 48 half-hourly estimates per day for the IMERG-based V3.1 vs. 8 three-hourly estimates per day for 1DD) may also play a role.



DISCUSSION AND FUTURE WORK

A number of updates are planned for the near future:

- Reprocess to scale the Daily record to the soon-to-be-released Version 3.2 Monthly record.
- Extend the Daily record through the end of 2020, then beyond when additional input data become available.
- Validate against regional daily gauge networks (e.g., MRMS).
- Develop a methodology to extend the Daily record backwards before the IMERG era (1983 through May 2000).

GPCP V3.1 Daily data may be accessed via

https://doi.org/10.5067/MEASURES/GPCP/DATA303 (https://doi.org/10.5067/MEASURES/GPCP/DATA303), or

https://disc.gsfc.nasa.gov/datasets/GPCPDAY_3.1/summary (https://disc.gsfc.nasa.gov/datasets/GPCPDAY_3.1/summary).

When the under-development V3.2 Daily becomes available, it is anticipated that it will be provided at the latter link with “3.2” in place of “3.1”.

Acknowledgment

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AUTHOR INFORMATION

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Eric Nelkin is a Research Meteorologist with Science Systems and Applications, Inc. at NASA Goddard Space Flight Center, Greenbelt, MD. After completing a B.S. (1990) and M.S. (1992) in Meteorology at Texas A&M University, he came to SSAI and GSFC in 1993. His initial work in the Severe Storms Branch, now called the Mesoscale Atmospheric Processes Laboratory, involved studies of the diurnal cycle of precipitation using SSM/I microwave data, and validation against gauges and atolls. He did extensive work in improvements of early versions of the Goddard Profiling Algorithm (GPROF). He created a popular time series chart depicting local equator-crossing times for various satellites, which he continues to update and distribute regularly. Over the years, he has developed code to grid Level 2 precipitation estimates for the TRMM Multi-satellite Precipitation Analysis (TMPA) and currently for the Global Precipitation Measurement mission's Integrated Multi-satellitE Retrievals for GPM (IMERG). He also works with AIRS and TOVS data for the Global Precipitation Climatology Project (GPCP), for which he led code development for the V3.1 daily product. He has been an author or co-author on numerous publications and presentations involving global satellite precipitation estimation.

ABSTRACT

The Global Precipitation Climatology Project (GPCP) recently released the Version 3.1 Daily dataset, providing state-of-the-art estimates of daily precipitation over the globe for the period June 2000-December 2019. The V3.1 Daily product features several enhancements over its predecessor, the V1.3 GPCP One-Degree Daily (1DD) product, including higher spatial resolution at 0.5° and more modern input data sources. Within the region 55°N-55°S, the V3.1 Daily is based on the half-hourly Integrated Multi-satellitE Retrievals for the Global Precipitation Measurement (GPM) mission (IMERG) V06B Final Run aggregated to the daily scale. In the regions 90°N-55°N and 55°S-90°S, the V3.1 Daily consists of an intercalibrated record of TOVS and AIRS precipitation estimates. Near 55°N and 55°S, an empirically developed “feathering” technique is used to minimize discontinuities at the boundaries between the IMERG and TOVS/AIRS domains. The daily precipitation estimates are calibrated to the V3.1 Monthly to control bias and create a consistent downscaling of the Monthly. In addition to precipitation, the V3.1 Daily also includes daily gridded estimates of probability of liquid-phase precipitation (PLPP), using the same scheme developed for IMERG.

We will show sample global maps and animations of V3.1 Daily precipitation and PLPP. Additionally, global time series of V3.1 Daily precipitation compared with 1DD will be presented, as well as regional validations against gauge data. Plans for future enhancements to the product will also be discussed.

As a living dataset, the record will be extended periodically as future input data become available. Furthermore, the Daily archive will be updated to maintain consistency with subsequent revisions to the Monthly record, and it will likely be further revised after the impending major upgrade to IMERG V07. While the GPCP Version 3 Daily and Monthly products are fine-tuned to Climate Data Record quality, the legacy GPCP datasets will continue to be produced. The overarching goal is to continue to provide a long-term record of global precipitation that applies the most modern methods throughout.

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Sims, E.M., and G. Liu, 2015: A Parameterization of the Probability of Snow-Rain Transition, J. Hydrometeor., 16, 1466-1477. doi:10.1175/JHM-D-14-0211.1

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