20+ Years after TRMM Launch

Global Precipitation: Means and Variations: GPM, TRMM and GPCP

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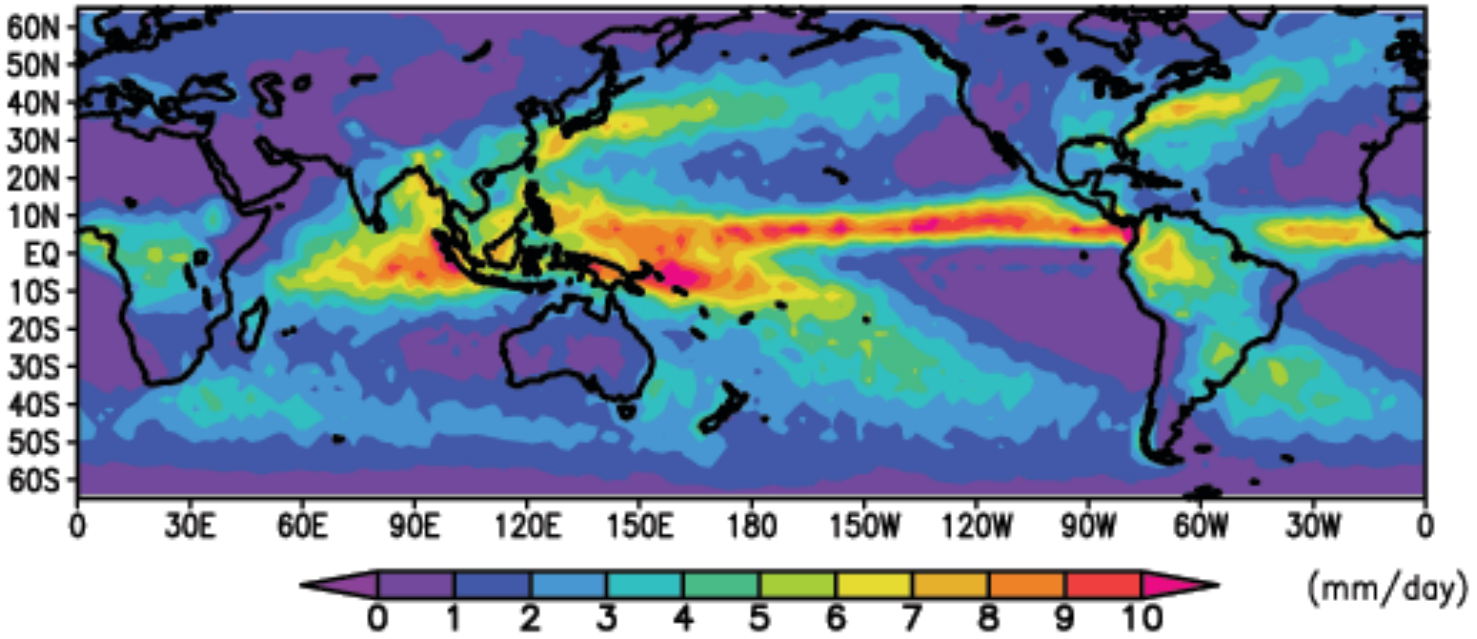
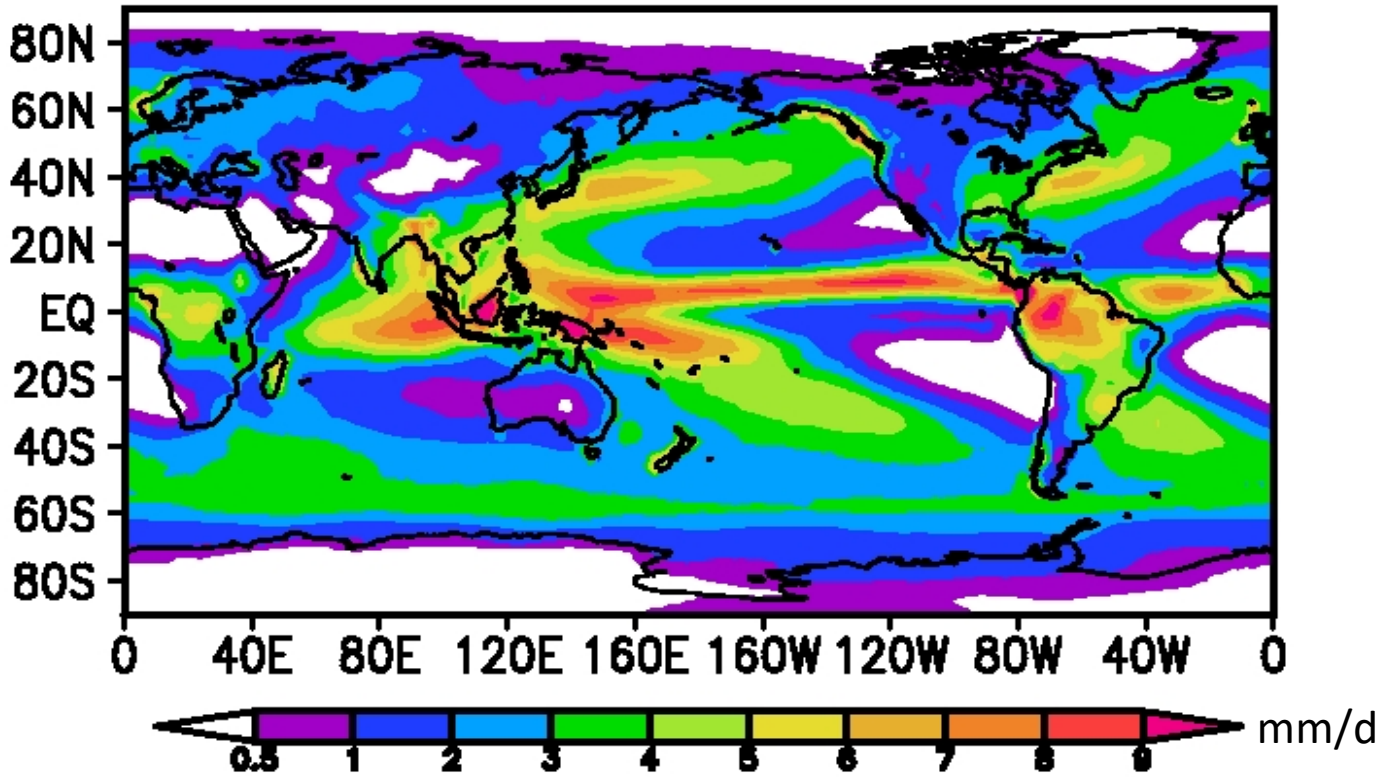
One Project Goal: A TRMM/GPM Composite Climatology (PMW, Radar, Combined)



Global Precipitation Climatology Project (GPCP)

Climatology (1979-2017)



GPCP is an often-used analysis based on satellite and gauge data (1979-near present).

No TRMM, GPM or Cloudsat data are in the current (V2.3) GPCP.

Adler et al., 2017 Rev. Geophysics *Adler et al., 2018 Atmosphere*

TRMM, CloudSat and GPM (IMERG) are being used in GPCP V3 (Huffman)

(In testing phase)

Absolute Magnitude of Global Precipitation from GPCP

	Ocean	Land	Ocean + Land
Precipitation	2.89 mm/d	2.25 mm/d	2.69 mm/d

Current GPCP global long-term number is **2.69 mm/d +/- ~7%**

With the error based on variations among different estimates (including TRMM)
(Adler et al. 2012 JAMC)

These global numbers and continental-scale values fit reasonably well with large-scale water and energy budget studies (e.g., Rodell et al. 2015 J. Clim.)

But, how well do these very large-scale precipitation numbers compare with TRMM, GPM and CloudSat?

GPM, TRMM and CloudSat should be the Standards to which the means of GPCP are tuned!

Then GPCP applies its algorithms/products to go back in time—to 1979

How do TRMM and GPM-based estimates fit with GPCP?

Tropical Mean Rainfall Estimates—Overlap Period

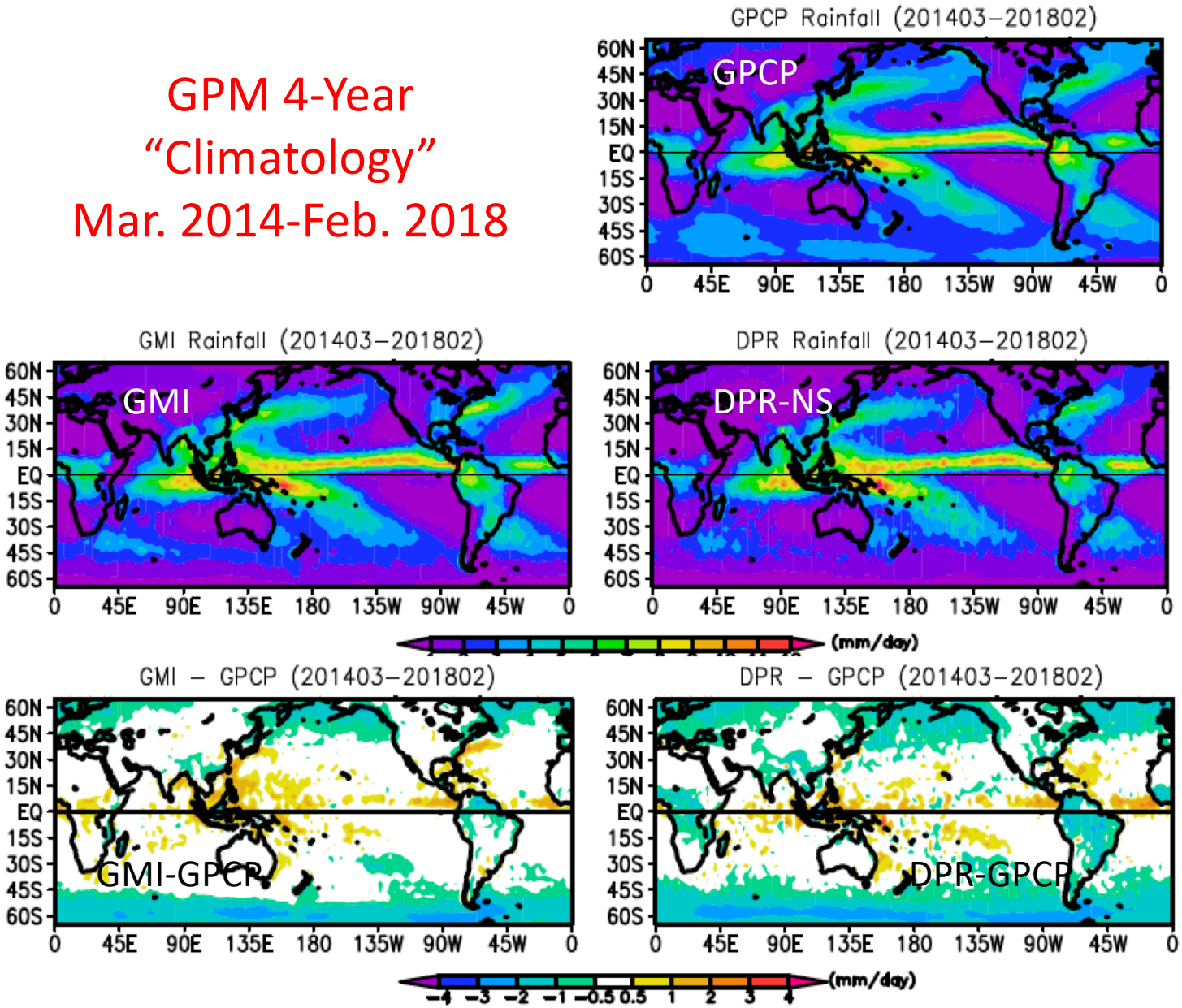
March-August 2014

	TRMM TMI	TRMM PR-NS	GPM GMI	GPM DPR-NS	GPCP
Ocean 25N-25S	3.5	3.3	3.4	3.4	3.2
Land 25N-25S	3.0	2.6	3.1	2.6	3.3

mm/d

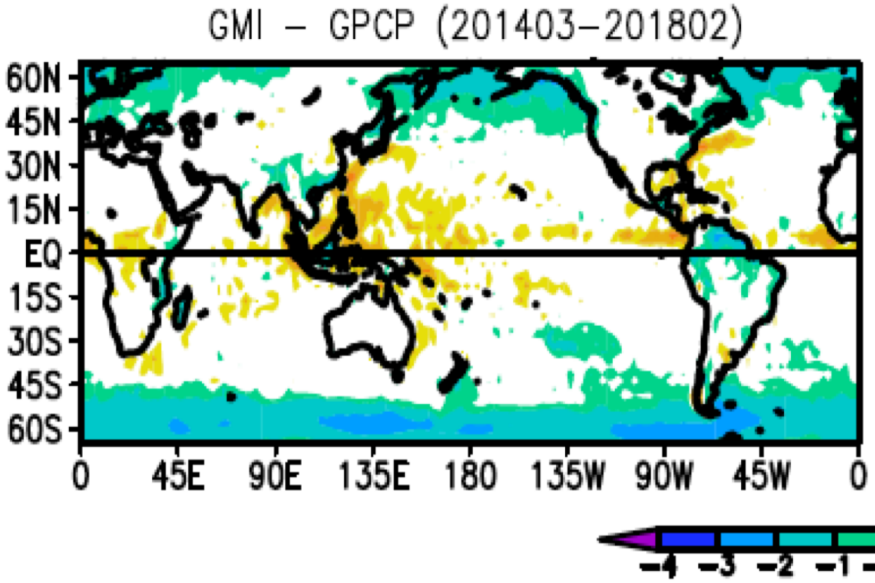
- TRMM and GPM ocean estimates in concert, a little larger (6-8%) than GPCP
- TRMM and GPM land estimates low compared to GPCP (includes gauges), especially PR/DPR *(20%, problematic for inclusion in a climatology)*
- Combined product not included—not ready; Radar products being re-done? Are products stabilized?

GPM 4-Year "Climatology" Mar. 2014-Feb. 2018

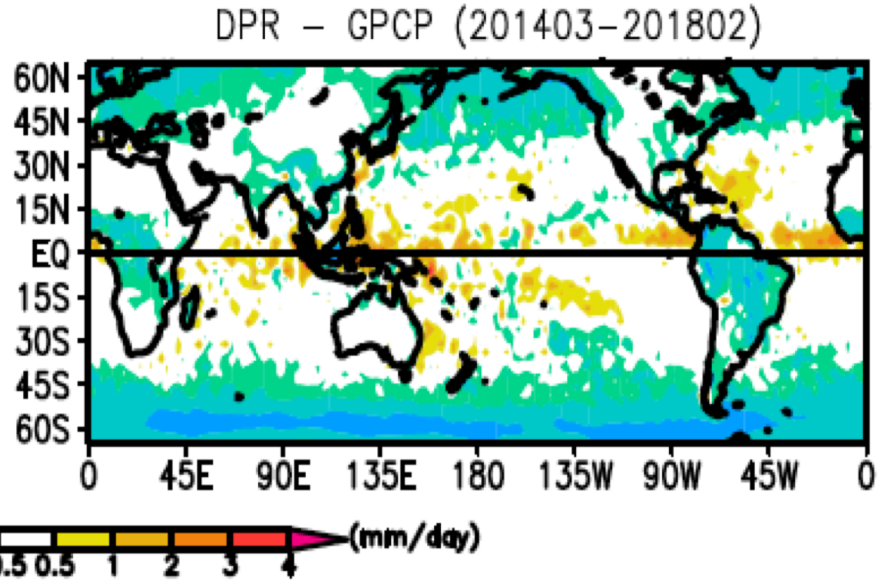


GPM 4-Year "Climatology"
Mar. 2014-Feb. 2018

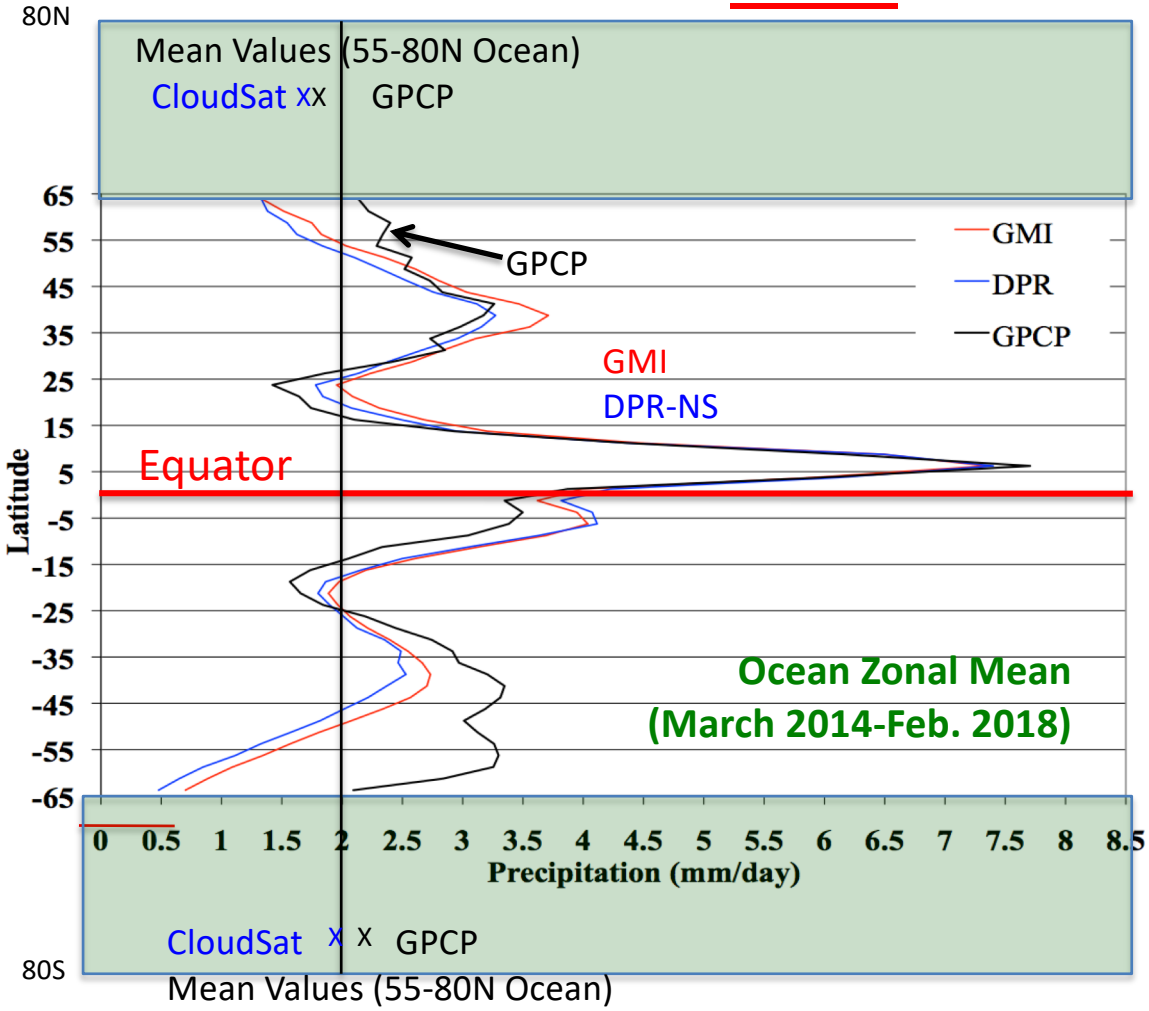
GMI-GPCP



DPR-GPCP



GPM Ocean Zonal Means



At low latitudes mean ocean values for GMI and DPR-NS (and GPCP) in "agreement". At higher latitudes (55N and 40S) GMI and DPR lower than GPCP.

At these high latitudes CloudSat-based estimates agree closely with GPCP means (over ocean and land); both higher than GPM

CloudSat High Latitude Study

Behrangi et al, (2016) JGR

Mean values of precipitation (rain plus snow) over five years, 55-80° latitude:

~ 2 mm/d

Trends and Inter-Annual Variations

Comparison of Water Vapor and Precipitation Changes in Relation to Temperature Changes

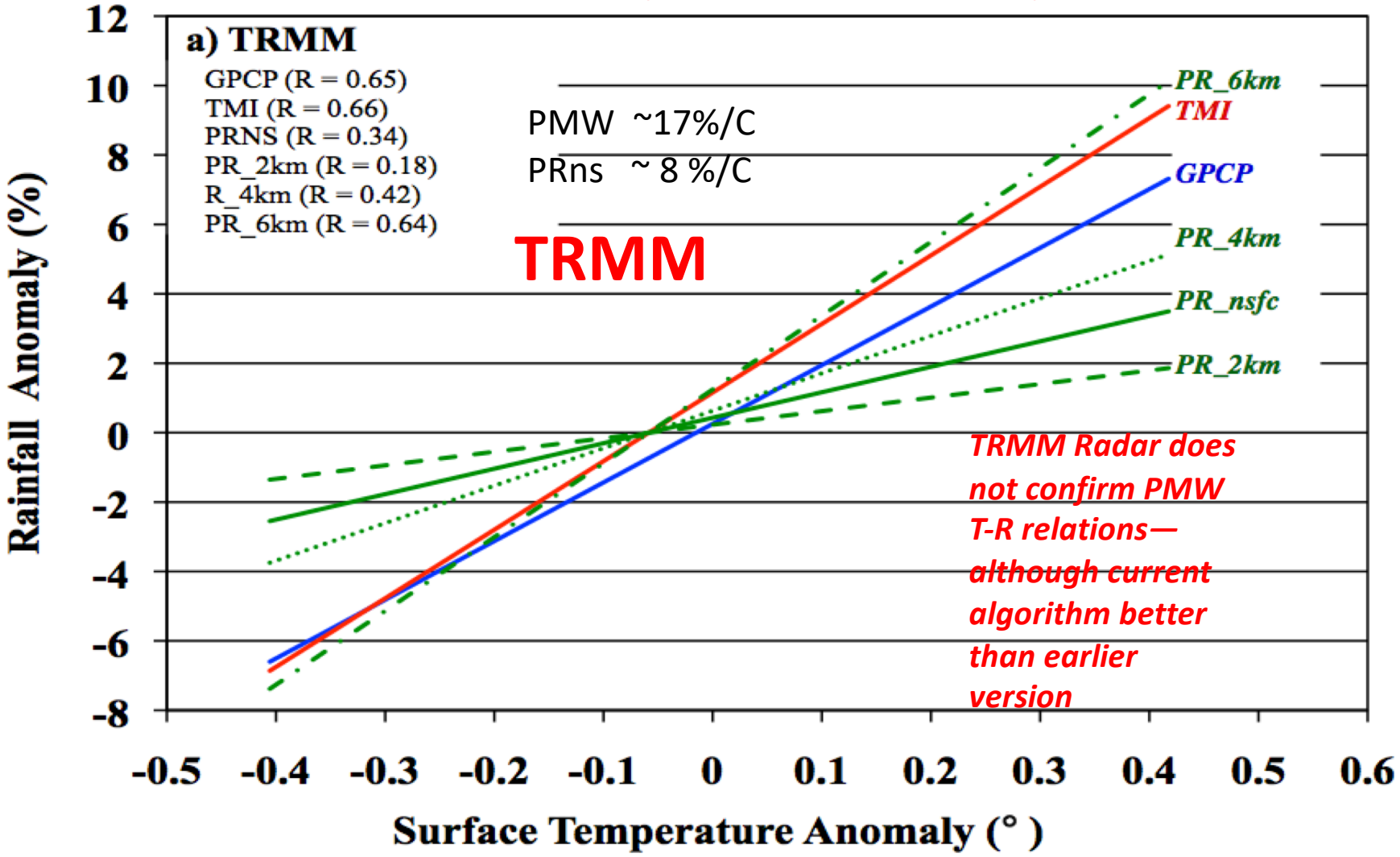
	Water Vapor	Precipitation (GPCP)
Trends	10 %/C (global ocean)	~ 1 %/C (global)
Inter-annual ENSO	15 %/C (global ocean)	9 %/C (global)

Precipitation variations vary differently from water vapor on trend scale, but are much more similar for inter-annual scale

These observational results (for precipitation) are based primarily on satellite PMW data—do the TRMM/GPM radar data confirm?

Slopes of TRMM-based Monthly Sfc. Temp.-Rainfall Relations (Radar vs. Passive Microwave)

1998-2013(Ocean, 25°S-25 °N)



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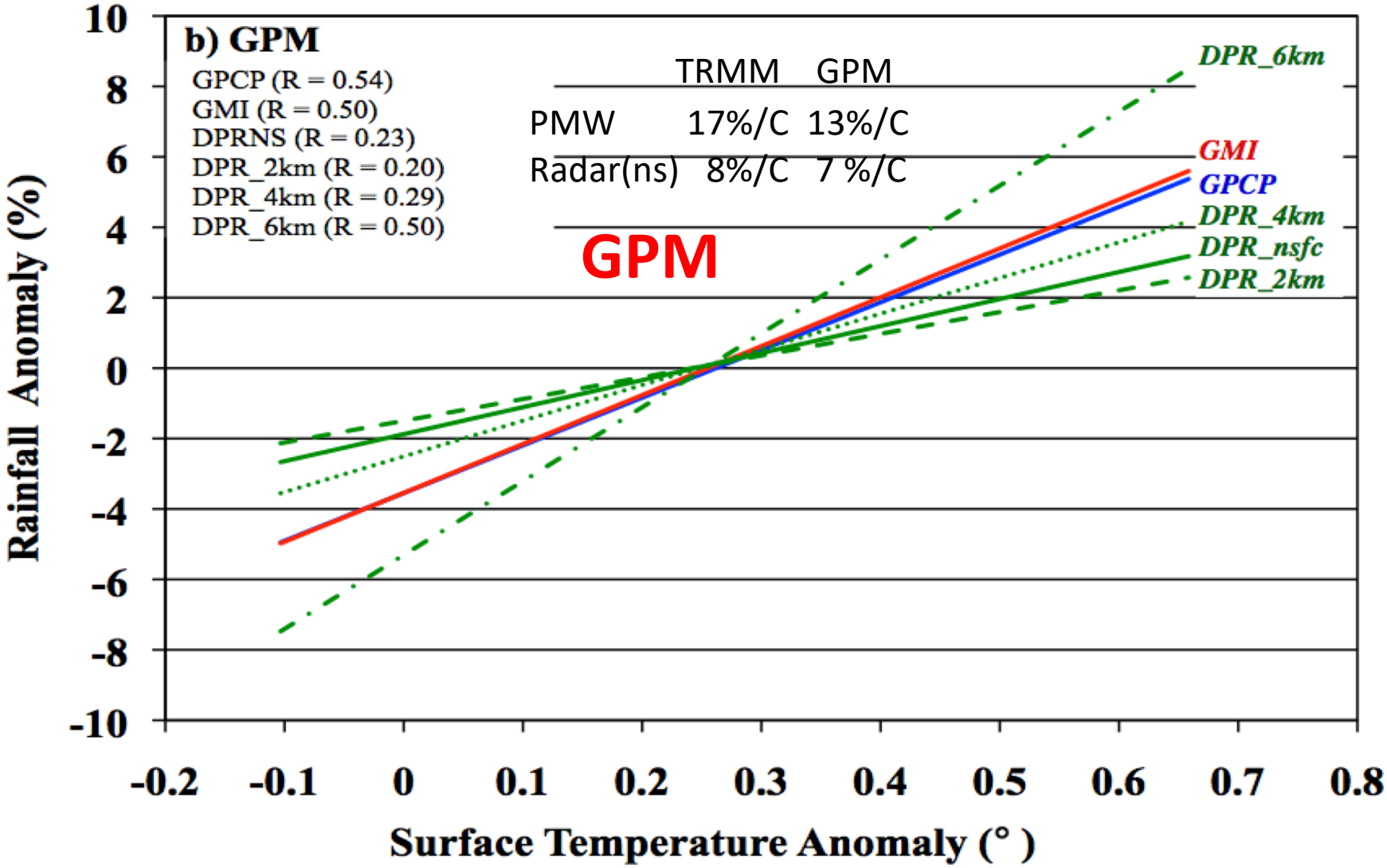
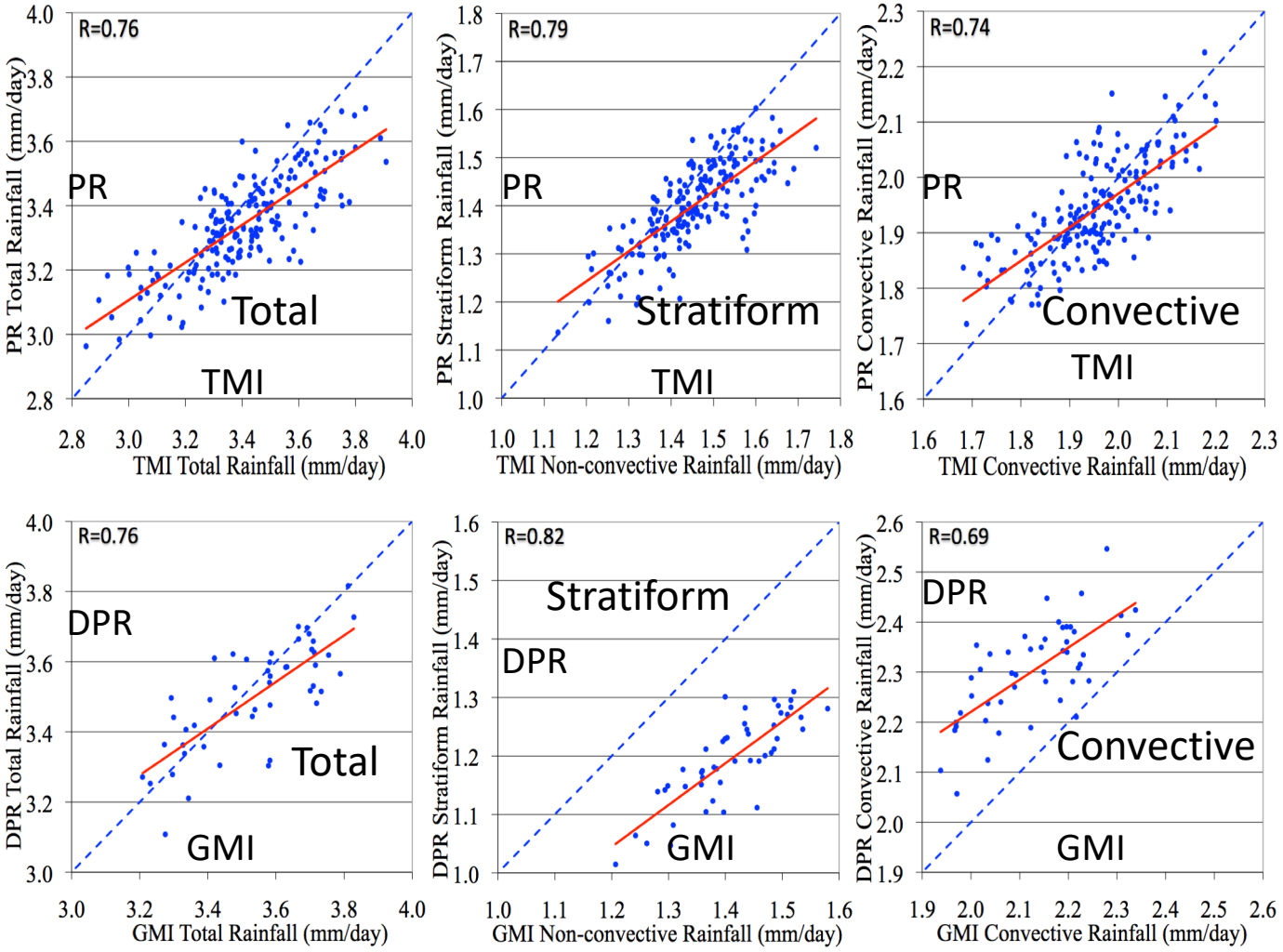
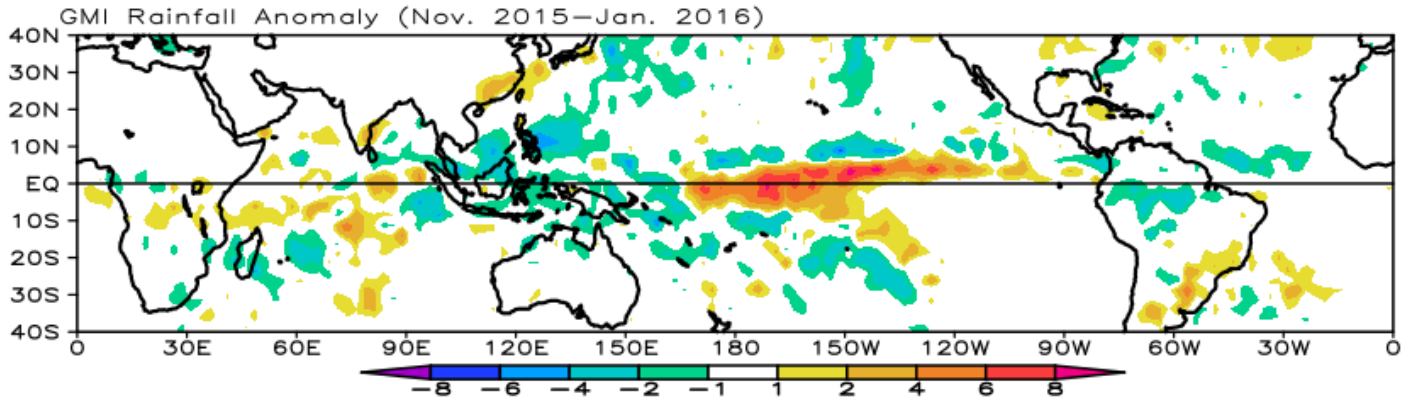


Inter-annual Variations of Ocean Tropical Rain (Passive Microwave vs. Radar)

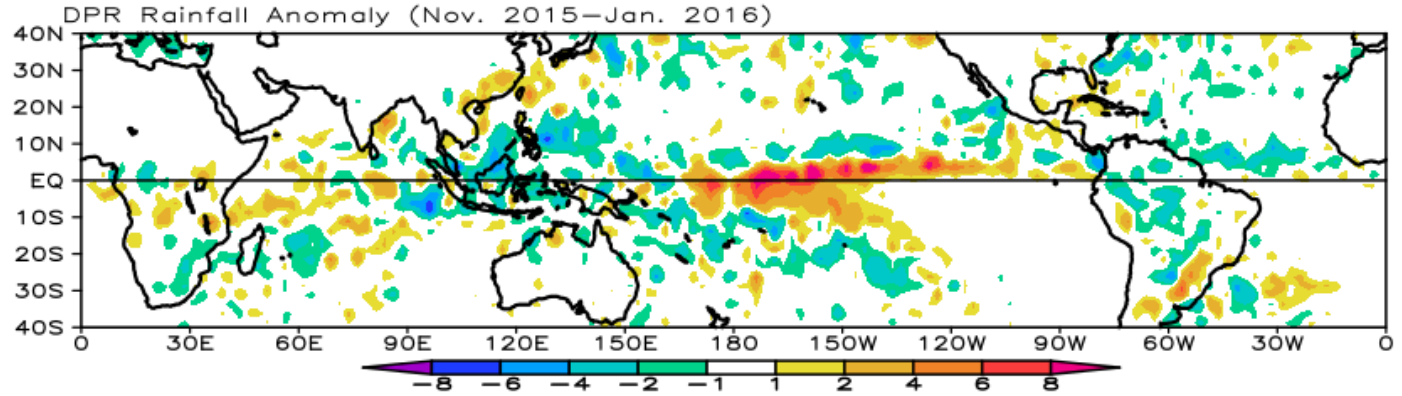


DPR has less stratiform and more convective rain

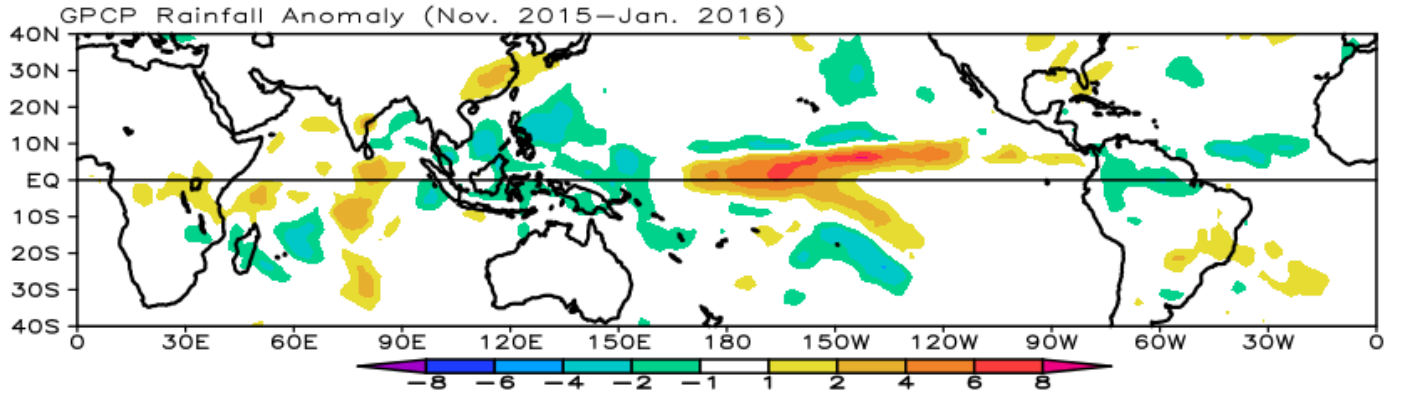
Precipitation Anomalies (2015-2016 El Nino)



GMI

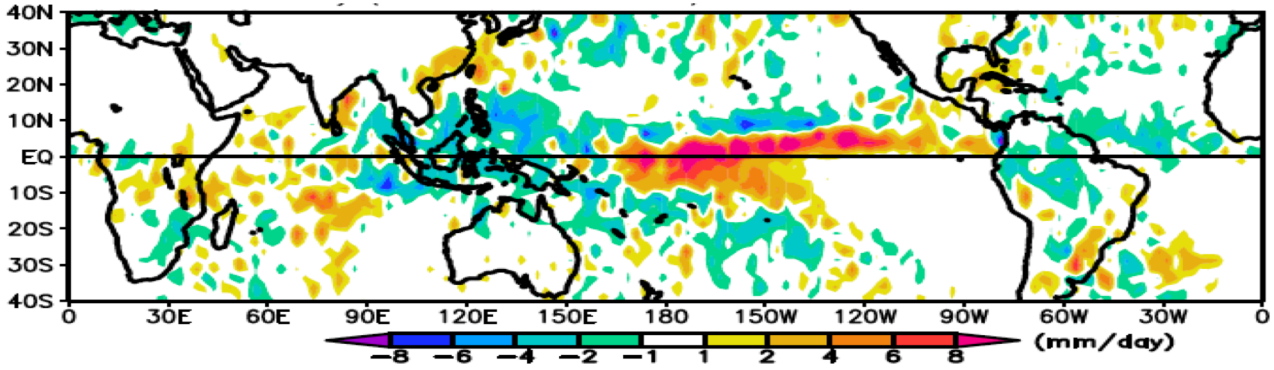


DPR

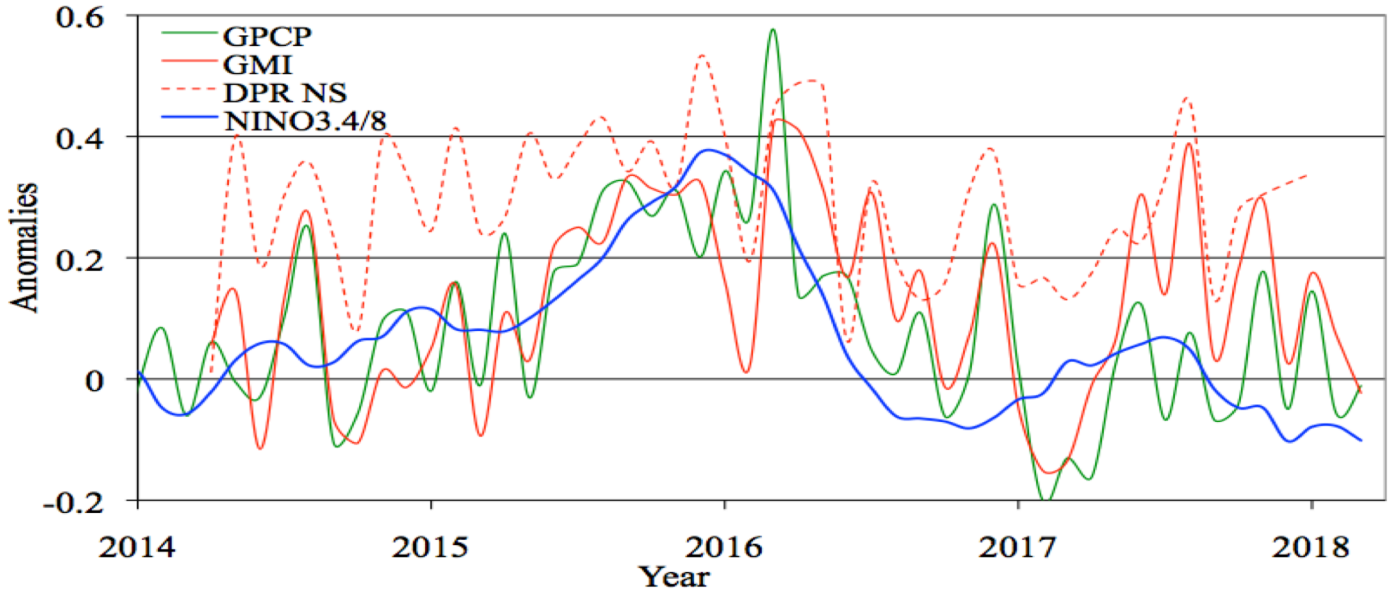


GPCP

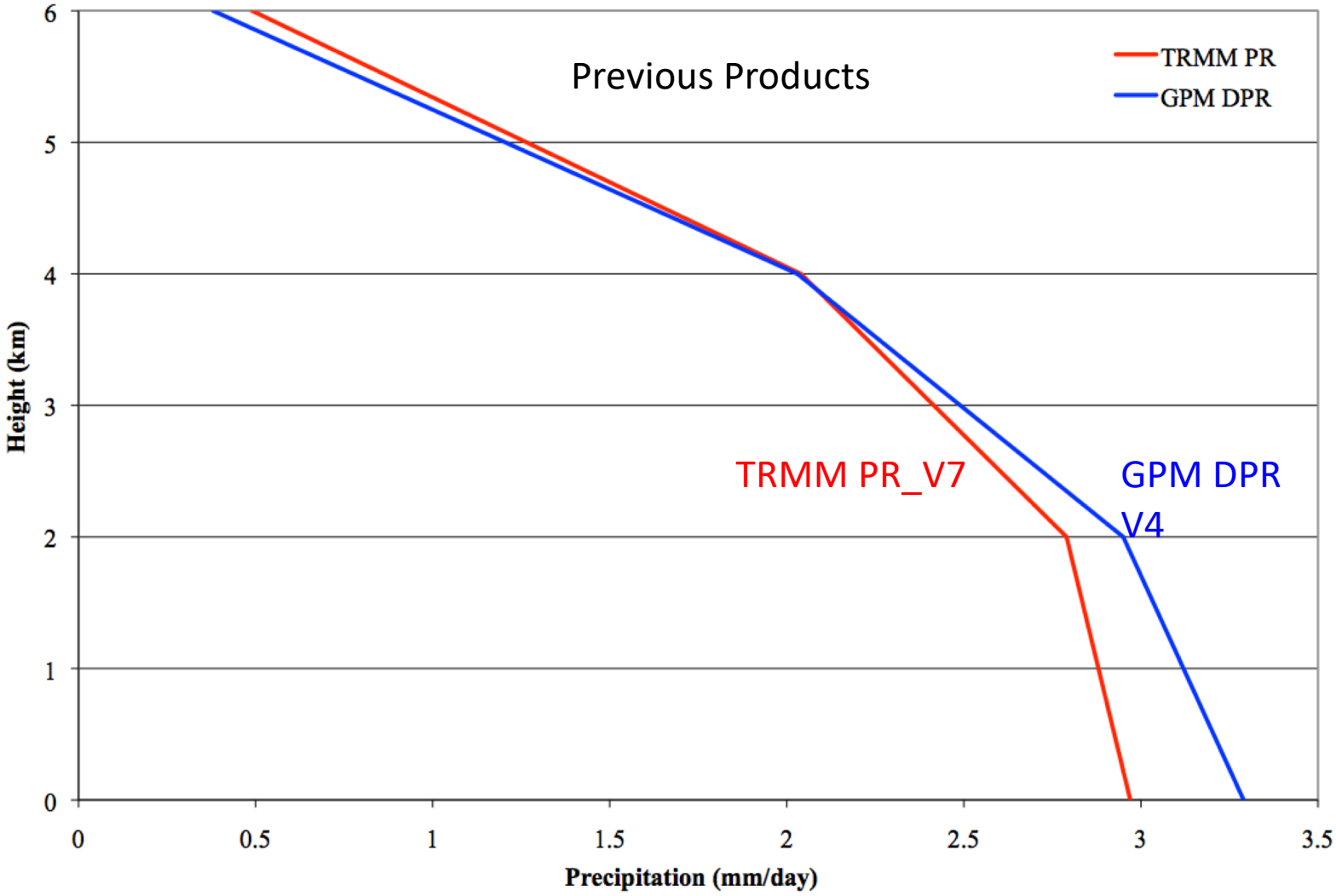
DPR Precipitation Anomalies (Nov. 2015 - Jan. 2016 El Nino)



GPCP& GPM Precipitation Ocean Anomalies (against TRMM mean) (25°S-25°N) vs. Nino3.4



Mean Precipitation Profile (mm/day) of Ocean (25°S-25°N) during Mar.-Aug. 2014 (TRMM/GPM Overlap)



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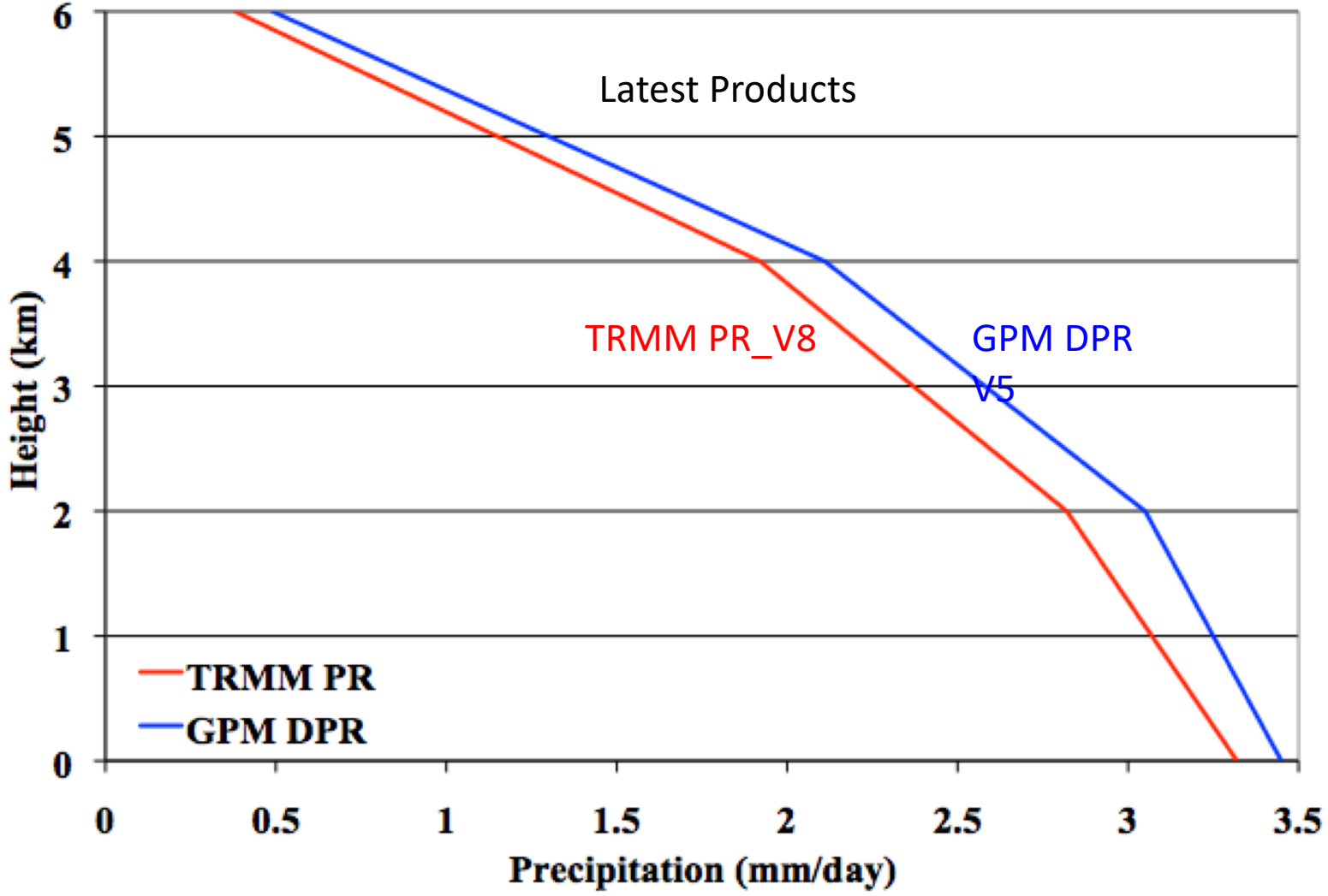

Summary

1. Over tropical oceans TRMM and GPM mean estimates (both PMW and Radar) slightly higher (~ 6-8%) than GPCP.

2. Over tropical land TRMM and GPM low compared to GPCP (with gauges), especially the Radar estimates (problematic). Needs attention, comparison to gauges, including analysis of regionally-varying biases

1. Over high latitude oceans GPM-based mean estimates are low compared to GPCP and CloudSat-based estimates.

1. GPM radar results for 2014-2018 (including El Nino) better agree with surface temperature – rainfall relations as compared to PMW results (including GPCP). TRMM radar results in this regard still show weaker relation, but now closer to DPR results.

2. Convective-stratiform differences between TRMM PR and GPM DPR troubling, but maybe changing with re-processing

3. Developing a TRMM/GPM Composite Climatology (multiple products) hampered by the low radar estimates over land, weaker response to ENSO by radars, and waiting for the Combined product.

Extra Slides