Global Precipitation Climatology Project (GPCP)

The GPCP Climate Data Record (CDR)--Global Precipitation Monitoring and Trends

GPCP is a NOAA NCEI CDR generated at UMD (gpcp.umd.edu) and is also an international (WCRP/GEWEX) collaborative effort

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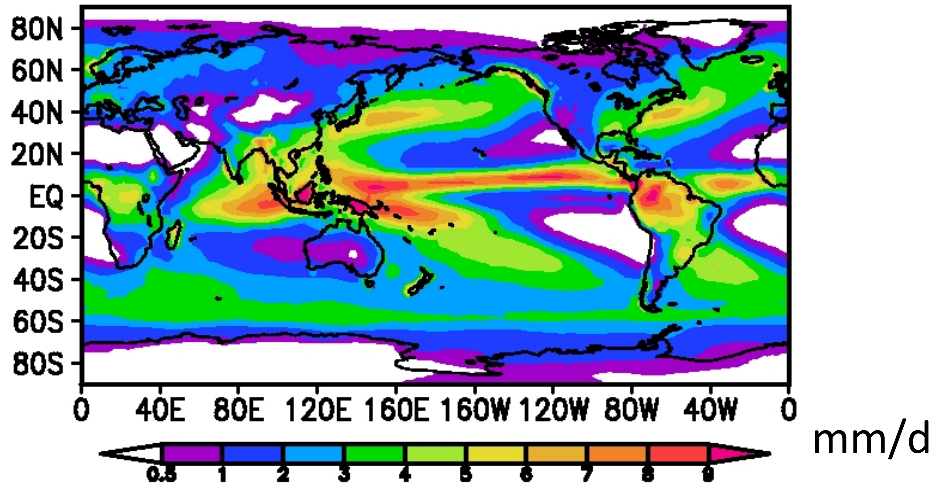
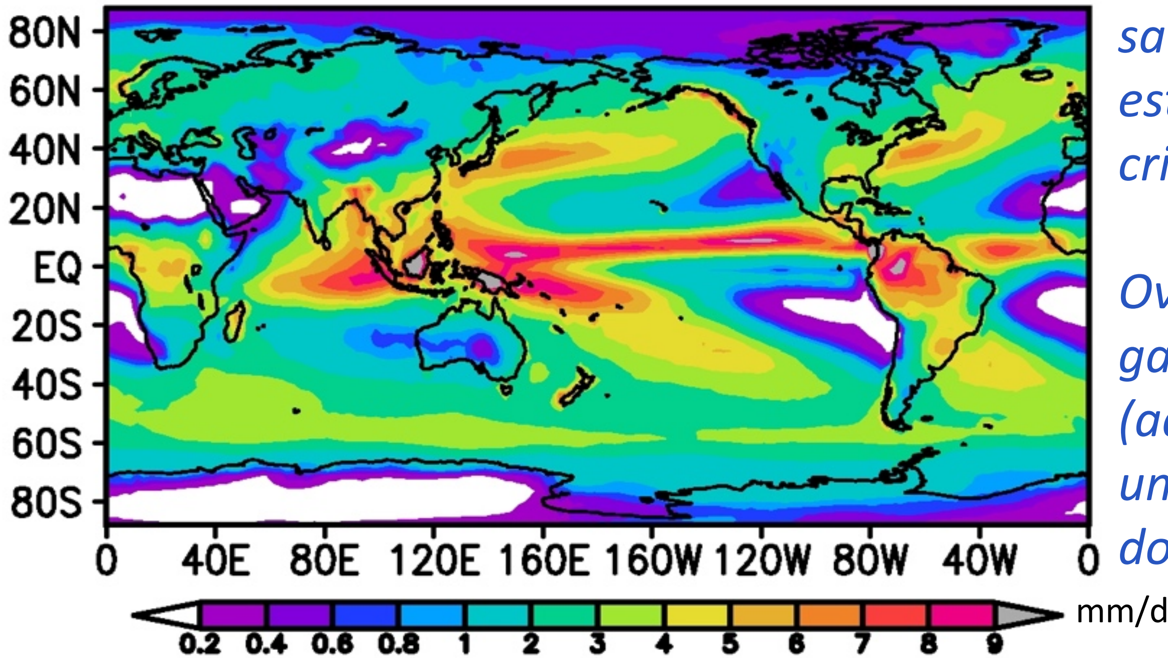
Climatology (1979-2018)



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

GPCP Climatology (1979-2018) 2.5º Lat./Long



Over ocean satellite-based estimates are critical

Over land gauges (adjusted for undercatch) dominate

GPCP Monthly Version 2.3

Also Daily Product(CDR) and Pentad product

- 40N-40S Ocean: Passive microwave from low-orbit (i.e., SSMI/SSMIS using METH/GMU algorithm) drives satellite estimates; Geo-IR estimates are used for diurnal adjustments and sampling
- Tropics/Mid-latitude Land: Passive microwave from low-orbit (again SSMI/SSMIS using Ferraro algorithm) is combined with gauge analysis; gauges dominate where dense
- Higher latitudes: Estimates from TOVS/AIRS sounders blended with gauges

Overall Quality: Very good, but with weaknesses…in polar regions, absolute value of satellite estimates over ocean, gauge undercatch estimates.

New version with improvements being developed (finer resolution, modern algorithms, TRMM/GPM/CloudSat data).

GPCP USAGE

Google Scholar search for "GPCP": 16,300 (1310 in 2018)
Total Journal Citations for GPCP Products: 4925

GPCP MONTHLY

Huffman et al., 1997: The Global Precipitation Climatology Project (GPCP) Combined Precipitation Dataset. *BAMS* *Web of Science Citations: 223*

Adler et al., 2003: The version 2 Global Precipitation Climatology Project (GPCP) monthly precipitation analysis (1979-present). *J. Hydrometeor*. *Web of Science Citations: 2820*

Huffman et al., 2009: Improving the global precipitation record: GPCP Version 2.1. *GRL* *Web of Science Citations: 545*

Adler et al., 2018. The Global Precipitation Climatology Project (GPCP) Monthly Analysis (New Version 2.3) and a Review of 2017 Global Precipitation. *Atmosphere*. *Web of Science Citations: 32*

GPCP PENTAD

Xie, et al., 2003: GPCP pentad precipitation analyses: an experimental data set based on gauge observations and satellite estimates. *J. Climate*. *Web of Science Citations: 223*

GPCP DAILY

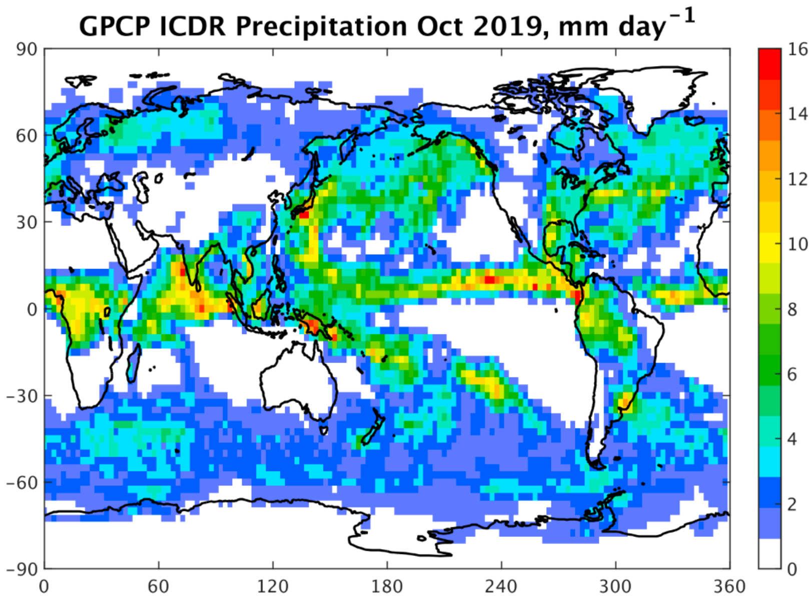
Huffman et al., 2001: Global Precipitation at One-Degree Daily Resolution from Multi-Satellite Observations. *J. Hydrometeor.* *Web of Science Citations: 1082*

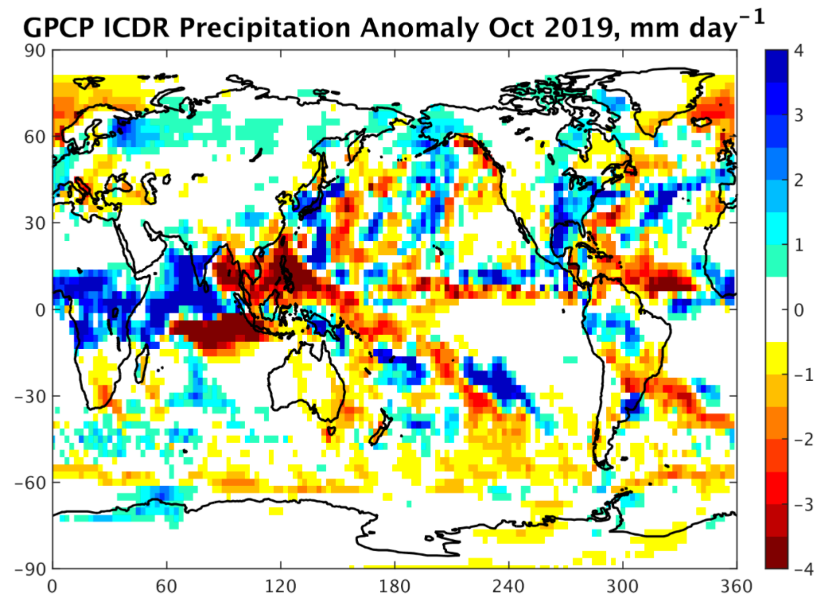
From NCEI ftp log requests about 10 downloads a month for each of GPCP Monthly and Daily data sets ~ 200 data set downloads a year

Connections to other NCEI CDRs and other data sets: RSS SSMI/SSMIS T_b's CDR; Ferraro land rainfall; PERSIANN CDR

October 2019

Interim CDR (ICDR) available ~10 days after end of month



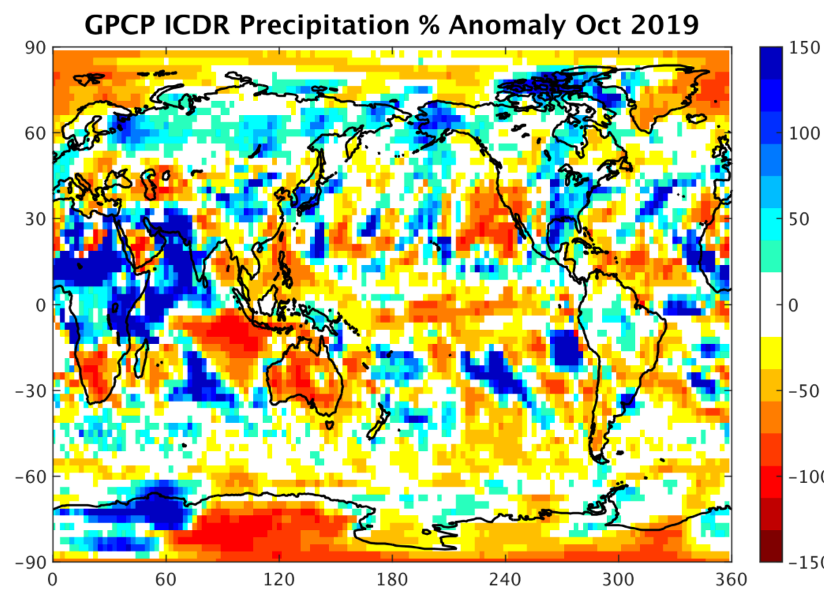


Heavy rain and flooding across central Africa from west to east coasts.

Asian summer monsoon ending with positive rainfall anomalies across the Arabian Sea and southern India and generally drier than normal conditions across Indochina and the Philippines

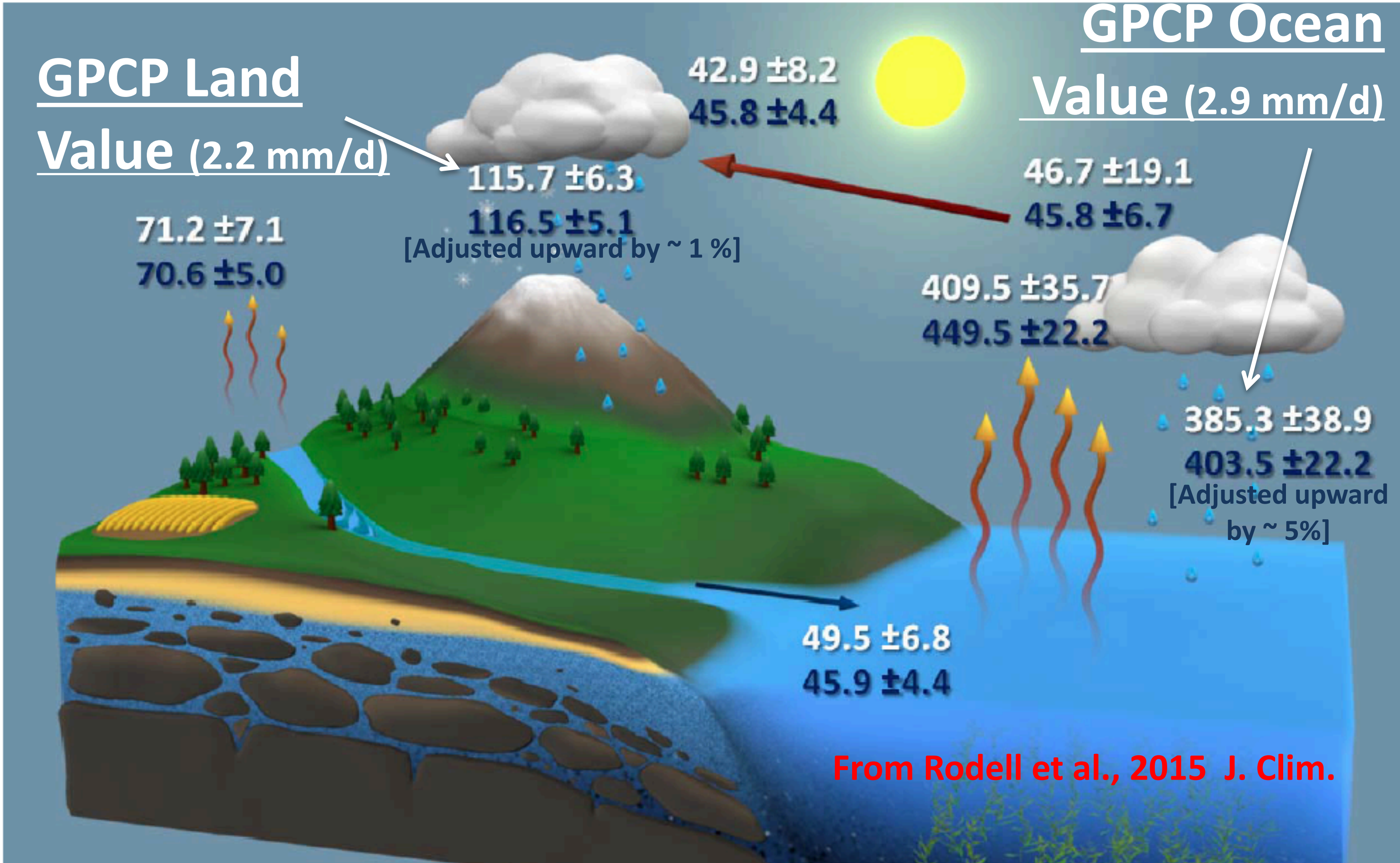
Tropical cyclone rain effects evident over Japan and Gulf of Mexico along U.S. coast

Dry conditions over southwest U.S. and Australia associated with wildfires



Global Mean Annual Water Cycle

Global mean water fluxes (1,000 km^3/yr) at the start of the 21st century



Best guess estimates from observations and data integrating models

When water balance is enforced, uncertainty decreases

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

Tropical Ocean Mean Rainfall Estimates (25N-25S)

1998-2018

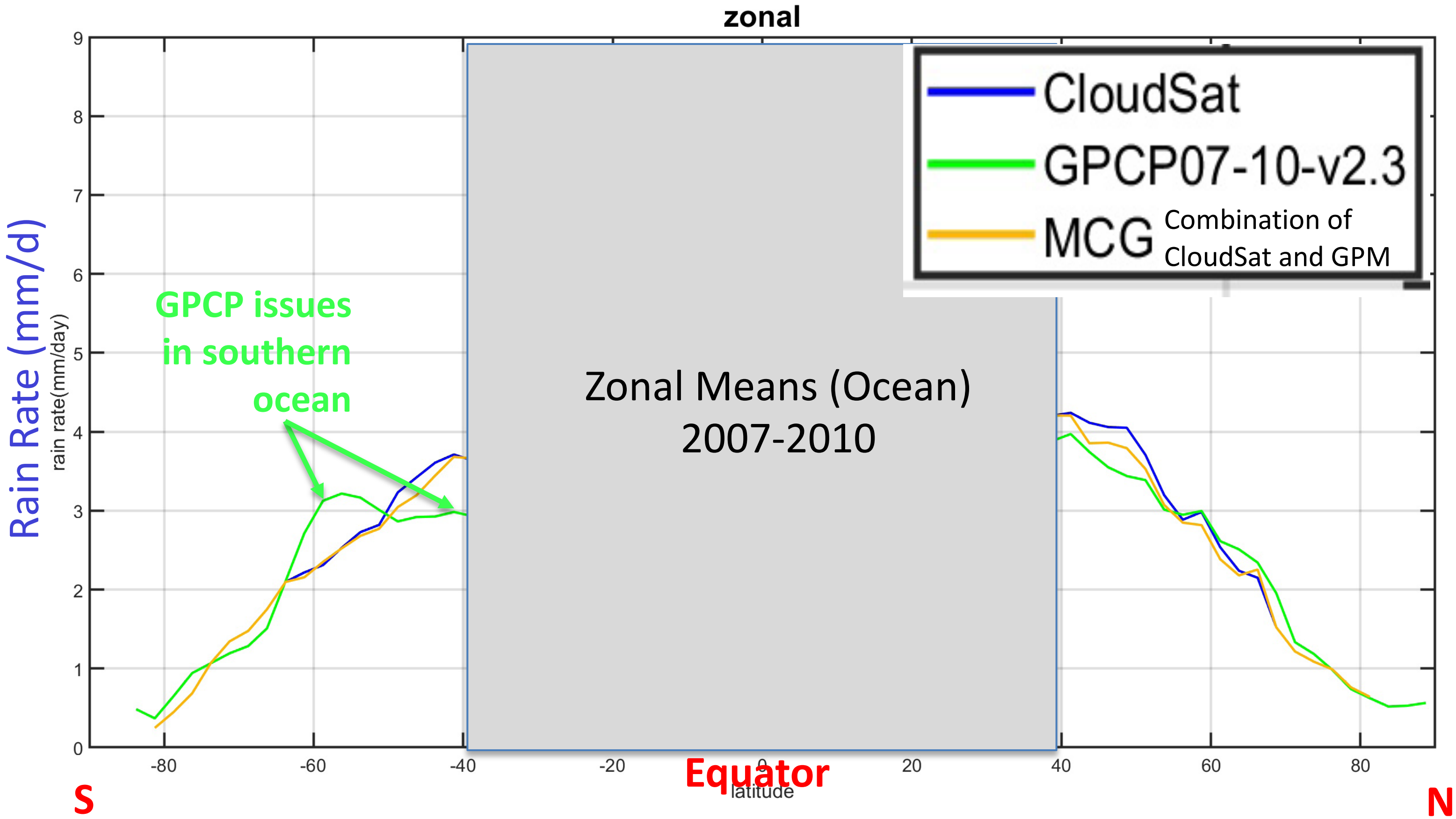
TRMM: 1998-2014; GPM: 2014-2018

	Passive Microwave	Radar	Combined	Composite *(mean of 1st three)*	GPCP	
Ocean 25N-25S	3.44	3.36	3.35	3.37	3.18	mm/d

- TRMM and GPM tropical ocean estimates in concert, a little larger (~6%) than current GPCP, smaller differences in sub-tropics/ mid-latitudes
- Differences vary spatially and seasonally
- So, the next version of GPCP will have larger tropical ocean mean estimates

CloudSat-based Estimates vs. GPCP

High Latitude Ocean

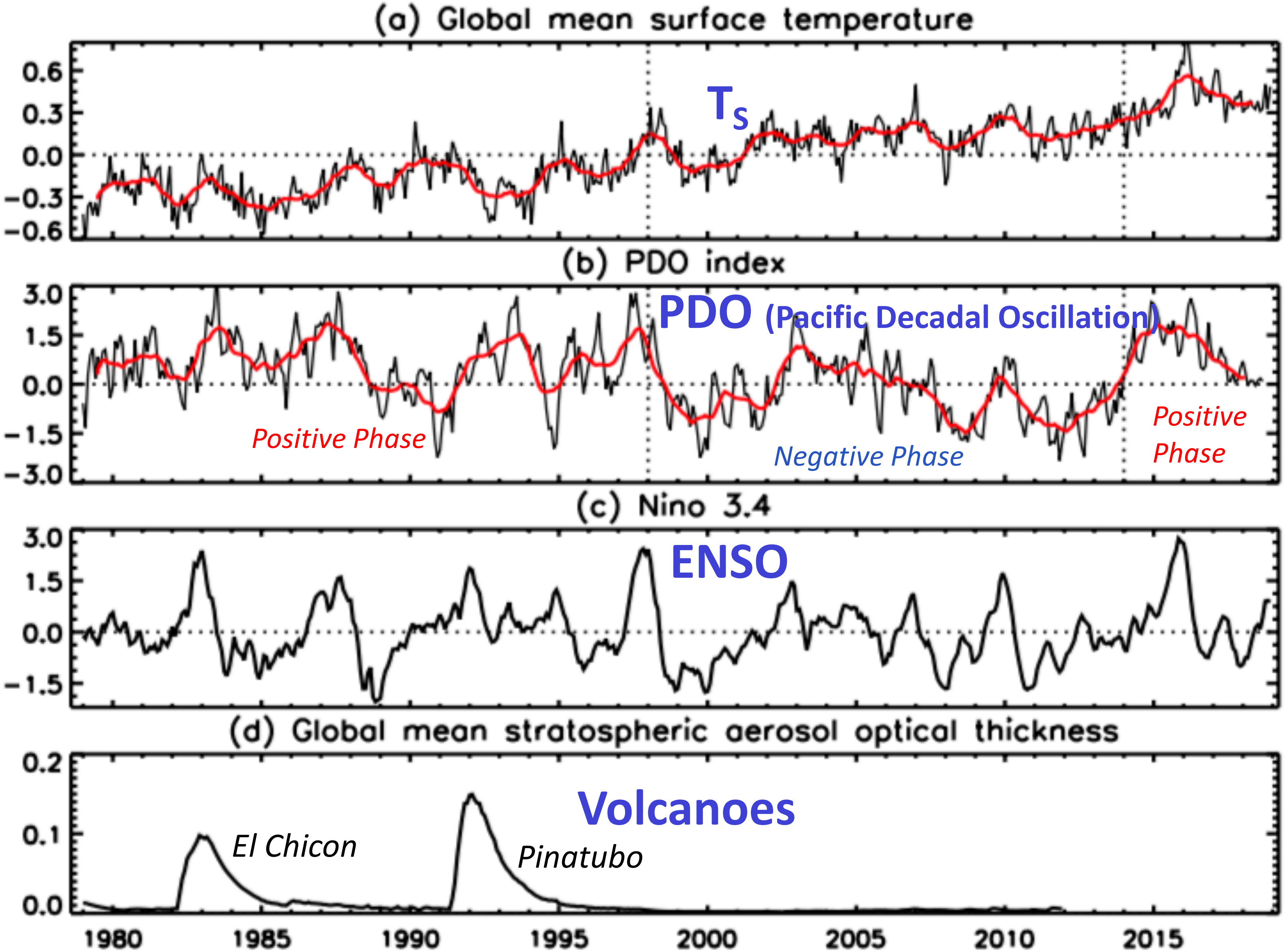


Generally mid-high latitude GPCP mean ocean values "validated" by CloudSat, except for southern ocean features

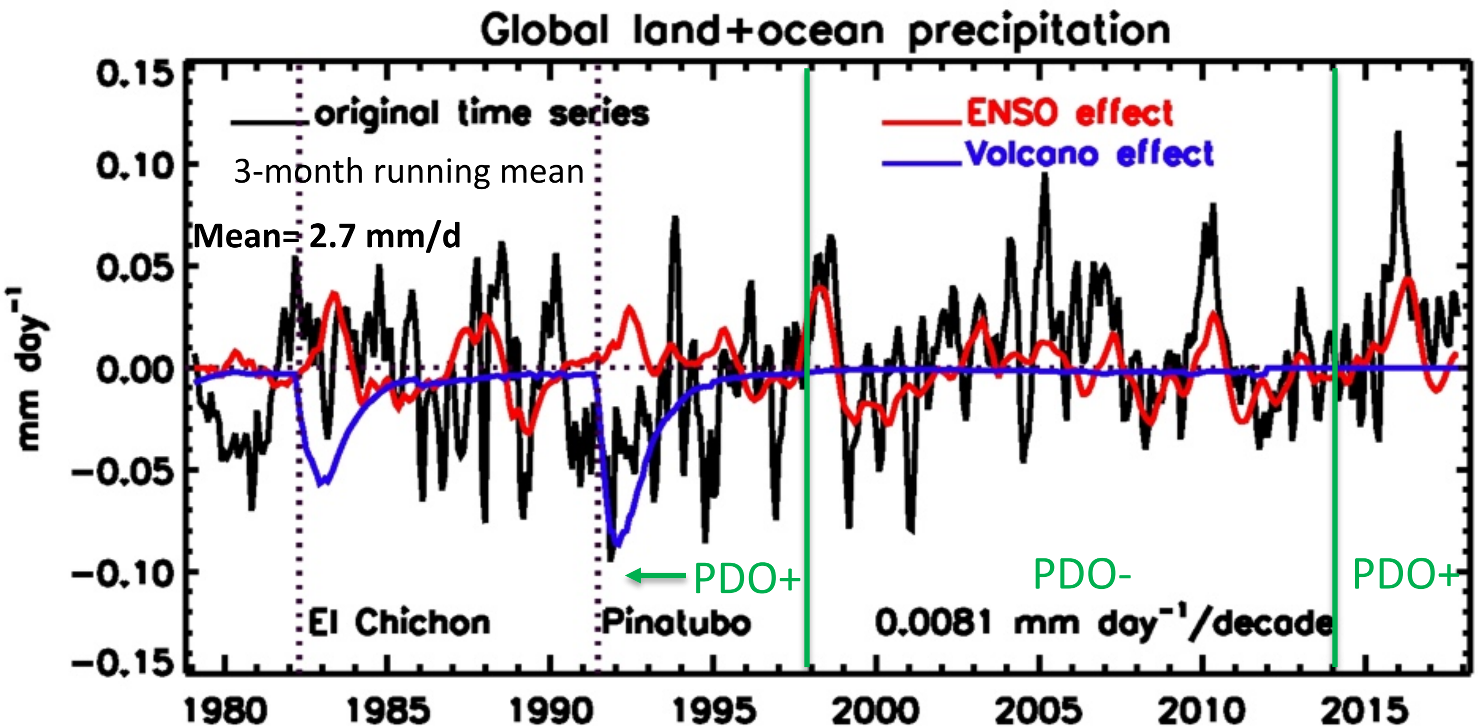
CloudSat analysis and figure from Behrangi (U. of Arizona)

Surface Temp., Pacific Decadal Oscillation, ENSO, Volcanoes (1979-Present)

"Forcings" on Precipitation



Time Series of Global Precipitation (1979-2017)

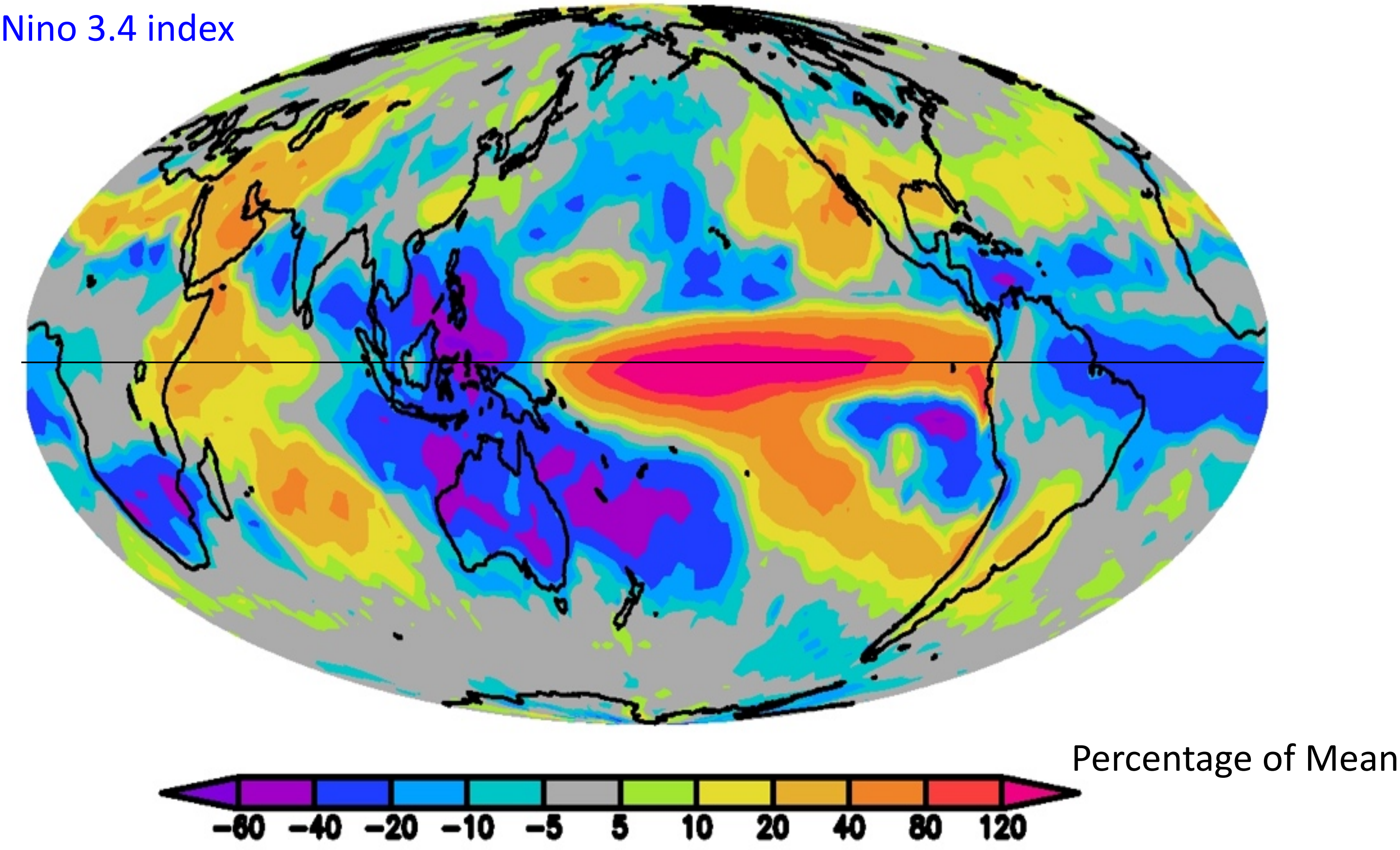


- Standard deviation (σ) is .03 mm/d (~ 1%)
- Trend is slightly positive [.01 mm/d/decade; 1.3%/K] (larger over tropical ocean), sensitive to length of record
- Maximum anomalies for El Nino (1998, 2010, 2016) are +.04 mm/d (~ 1.5%), despite positive/negative anomalies over ocean/land.
- Maximum anomaly for volcano (-.09 mm/d [~ 3%]). Over both land and ocean.

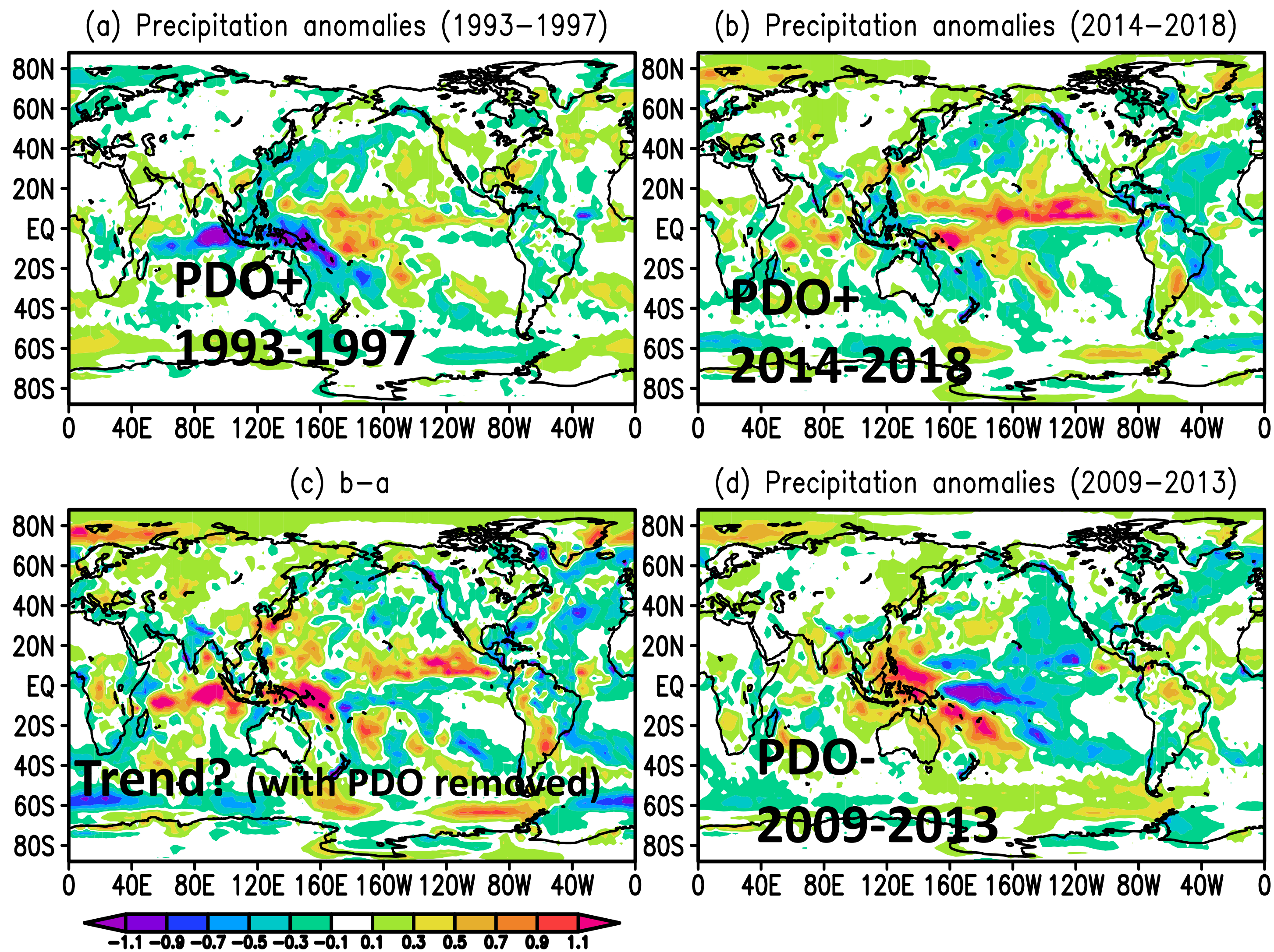
Adler et al., 2017 Rev. Geophysics

Composite ENSO <u>Precipitation</u> Anomalies (1979-2017)

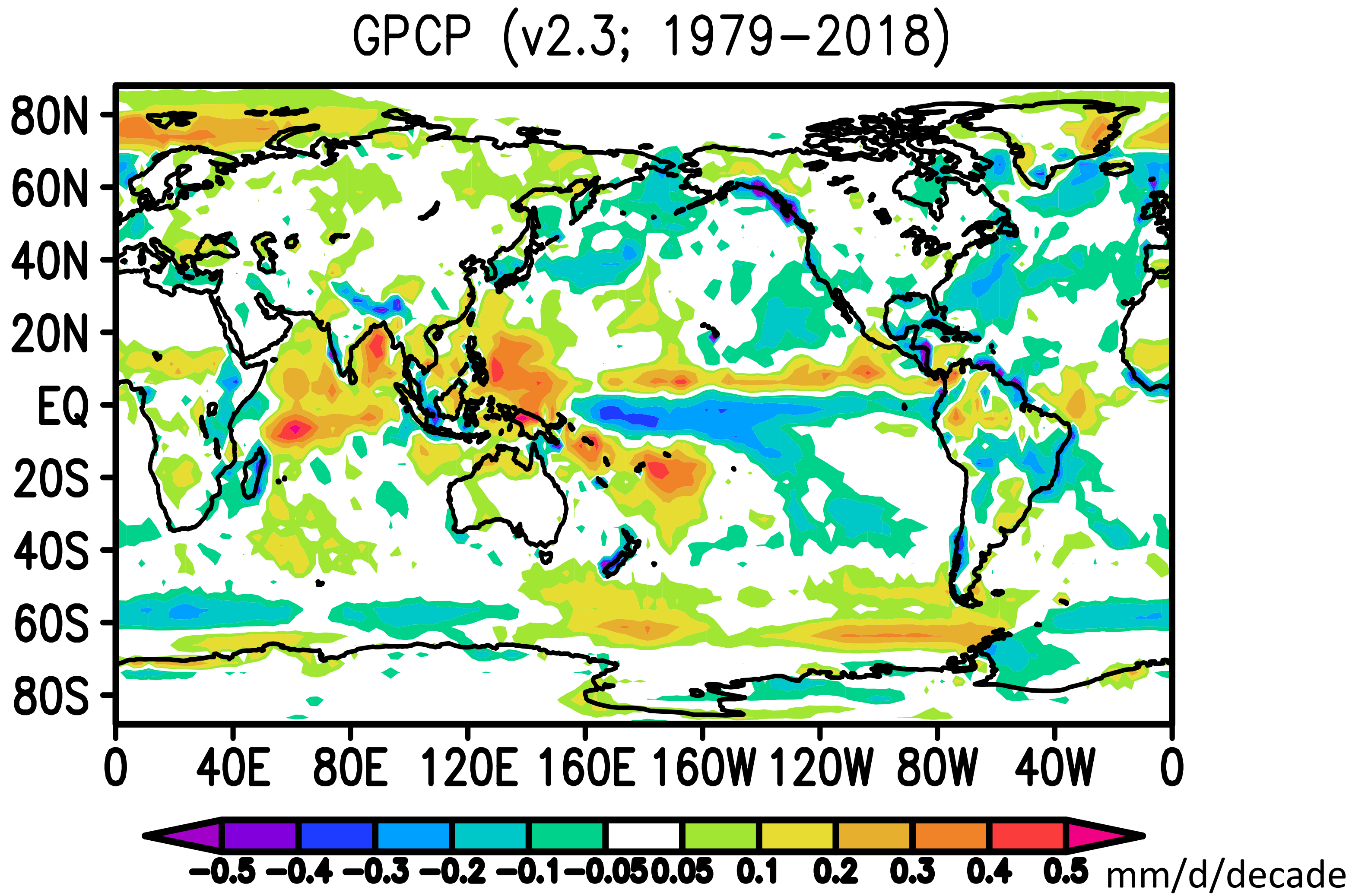
El Nino – La Nina Months
using Nino 3.4 index



PDO-Related Precipitation Anomalies (Positive and Negative Phases)



Pattern of Global Trends



Trend Pattern related to Global Warming (GW) with a little inter-decadal signal on top

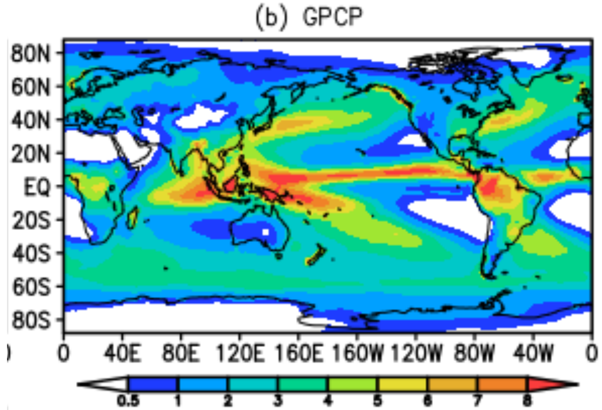
GPCP Observations and Climate Models

CMIP5/6 monthly precipitation from ensemble of multiple climate models:

1) **AMIP**: AMIP-type simulations (driven by observed SST, ice extent, and historical radiative forcings) *Should simulate GW and PDO*

2) **CMIP:** Hist-Full; Coupled historical full radiative forcings simulations *Should simulate only GW and other long-term effects*

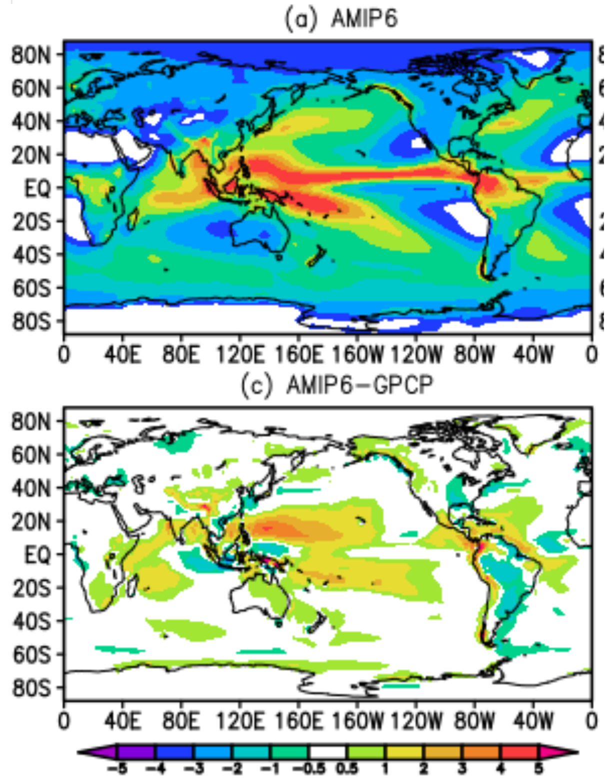
Climate Models and GPCP

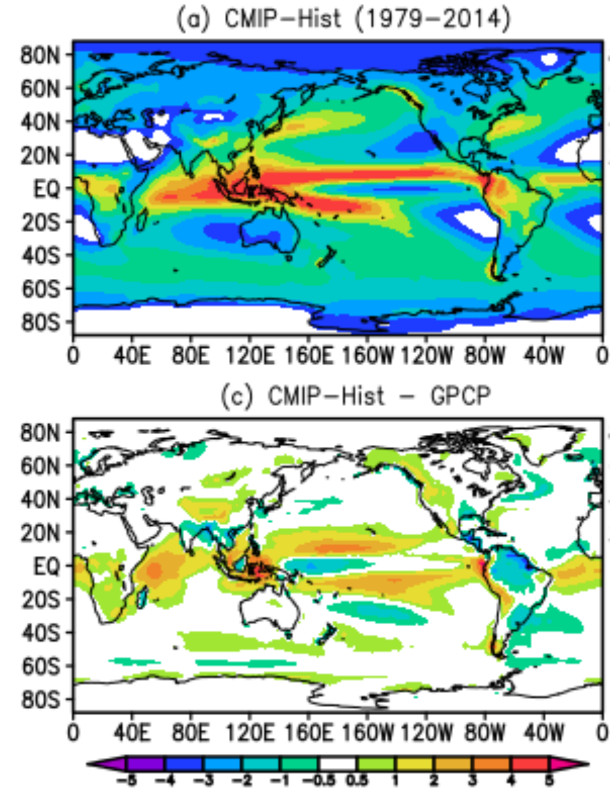


Global mean precipitation (mm day^{-1}) (1979-2014)

GPCP	AMIP6	CMIP5
2.69	3.02	2.97

Climate Models ~ 10% higher than GPCP

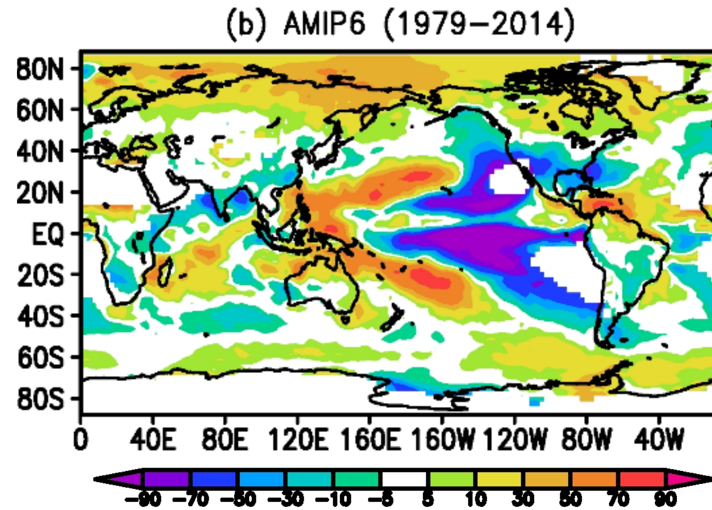




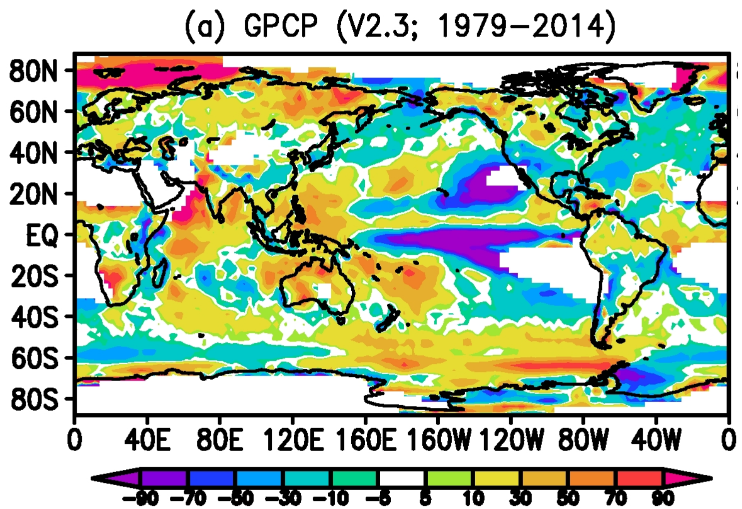
Trends in Precipitation

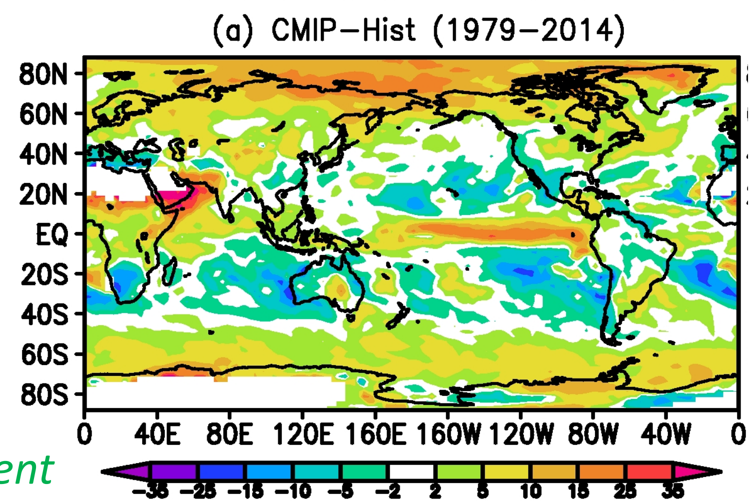
In terms of percentage change per degree of global warming (%/K)

AMIP-6 Ensemble



GPCP



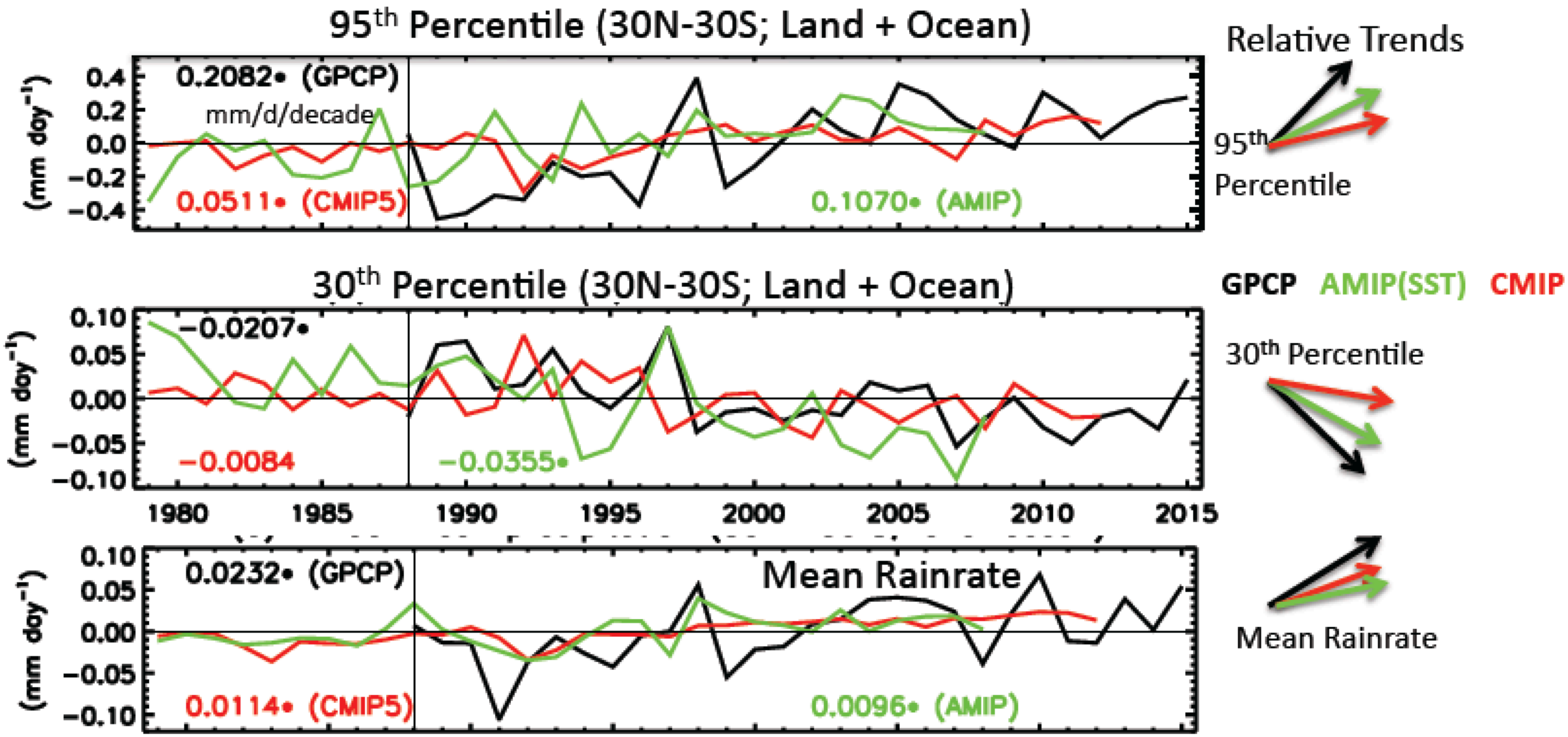


CMIP scale is different
(weaker by factor of ~2.5)

CMIP-5 Ensemble

Trends in Rainfall Intensity at the Monthly Time Scale

Percentile Changes/Trends: GPCP AMIP-5(SST) CMIP-5

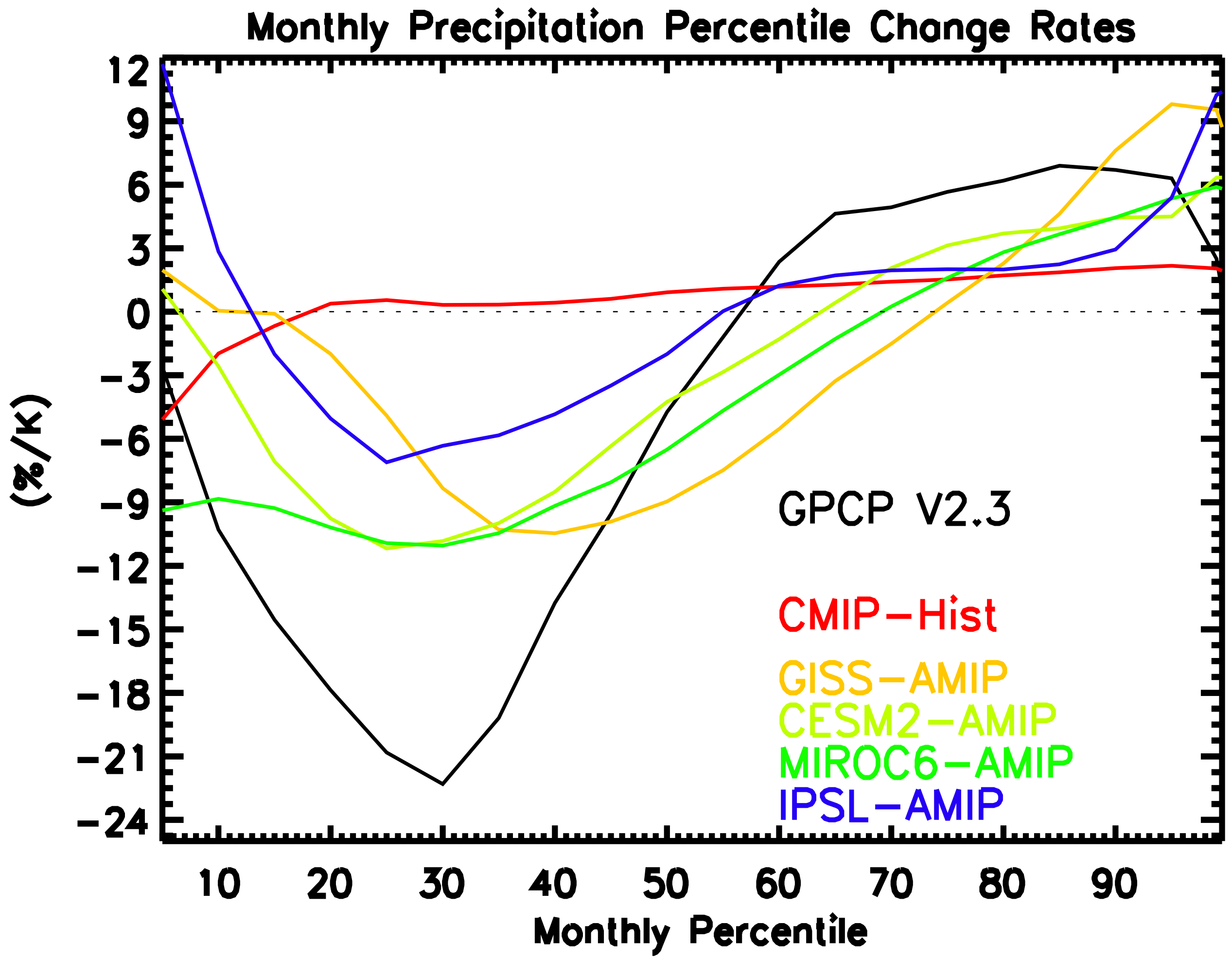


- For Intense rain (90-95th Percentile) trend is up for observations (GPCP) and both model types, with trend magnitude GPCP>AMIP> CMIP.
- For Intermediate rain rates (e.g., 30th Percentile) trend is down for observations and models, with trend magnitude again GPCP>AMIP> CMIP.
- **Interpretations: 1) Models may be underestimating intensity changes related to warming; 2) AMIP>CMIP magnitudes may indicate relative GW+PDO vs. GW effects**

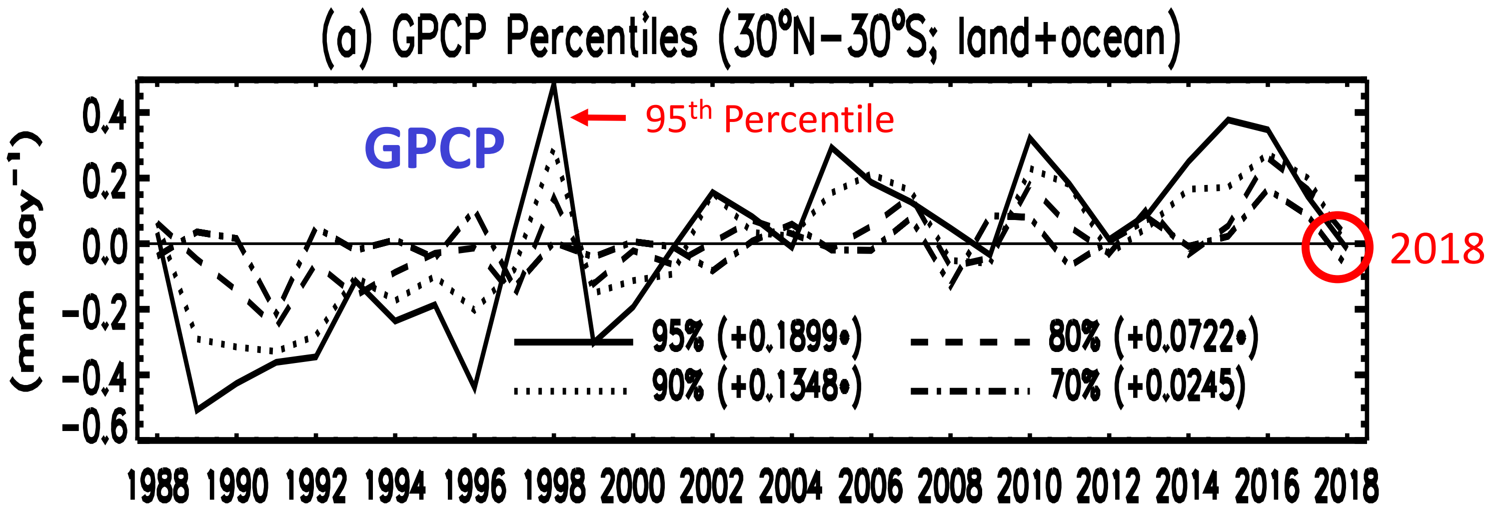
Gu and Adler (2018) J. Climate

Global Monthly Precipitation Percentile Trends (%/K)

Area Weighted (1988-2014)



Trends in Tropical Monthly Rainfall Intensity



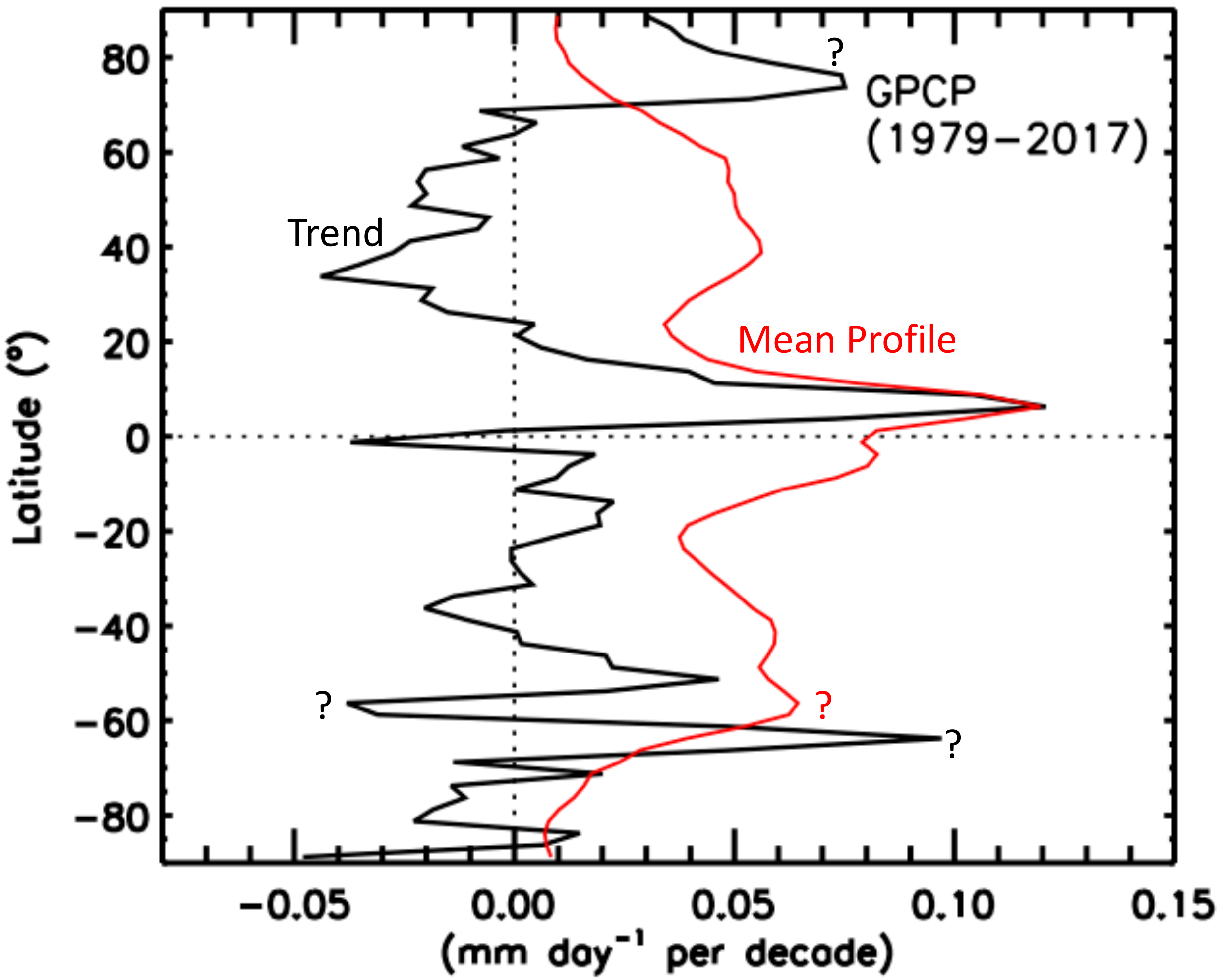
Mean tropical rainfall trend: 5.0%/C
95th Percentile rainfall trend: 13.3%/C

Summary

- GPCP Monthly Analysis provides high quality, long-term global precipitation information, including a "real-time" climate monitoring product
- Climatological mean values reasonable, but may increase over tropical oceans when TRMM and GPM information are incorporated
- High-latitude information generally good, but with some features and trends needing improvement—this is one focus of current NASA project
- Planetary mean precipitation increasing slightly (significant?) with noticeable impacts of ENSO (1.5%) and volcanoes (3%)
- ENSO-related pattern of anomalies is dramatic and extensive
- Trend maps show strong features over tropical oceans with increases along ITCZ, decreases in northern mid-latitudes
- GPCP-based trends partially validate climate models and provide a "best" estimate from observations for evaluation of models
- Trends in Intensity in tropics at the monthly scale have intense rains increasing, dry areas expanding, same in sign (but not magnitude) as models
- CMIP models used for projections do not match well with observed pattern of trends or trends in intensity

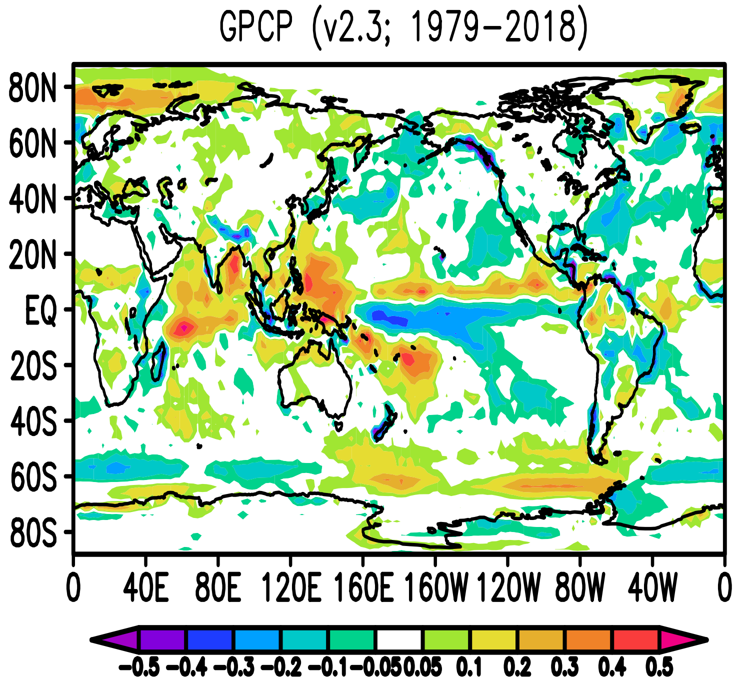
EXTRA SLIDES

Zonal-Mean Trends



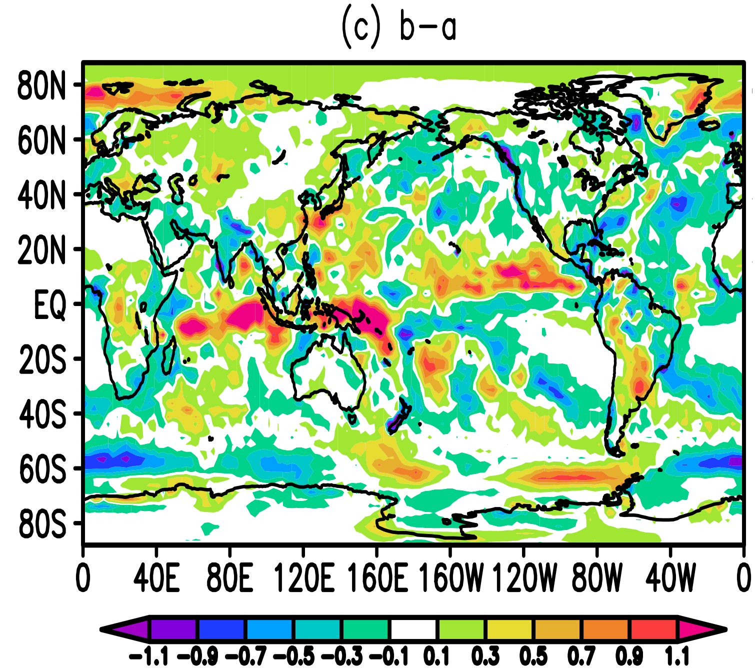
Pattern of Global Trends

Straight Trend



mm/d/decade

Later PDO+ minus Earlier PDO+



mm/d