

Global Climatology of Surface Precipitation: Role of TRMM and GPM

*A Thirteen-Year Tropical Rainfall Climatology Based on a
Composite of TRMM Products*

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Importance of TRMM/GPM Climatology (and Monthly Products)

- Original TRMM science question: “How much rain is falling in the Tropics, especially over the ocean?”
- Mean values of precipitation important for regional and global water and energy balance studies, global model validation, etc. (Also entry TRMM products for wider community—applications, outreach, education)
- TRMM (and GPM) has strengths in terms of multiple estimates; but which to use, how to handle boost? What is one “best” TRMM estimate? And what are the error bars?
- One answer: TRMM Composite Climatology (TCC) of surface rainfall over the Tropics using the strength of multiple estimates from TRMM. (Adler et al., 2009 JMSJ)

Selected TRMM Rain Products for TRMM Composite Climatology (TCC) [using V6]

Ocean:

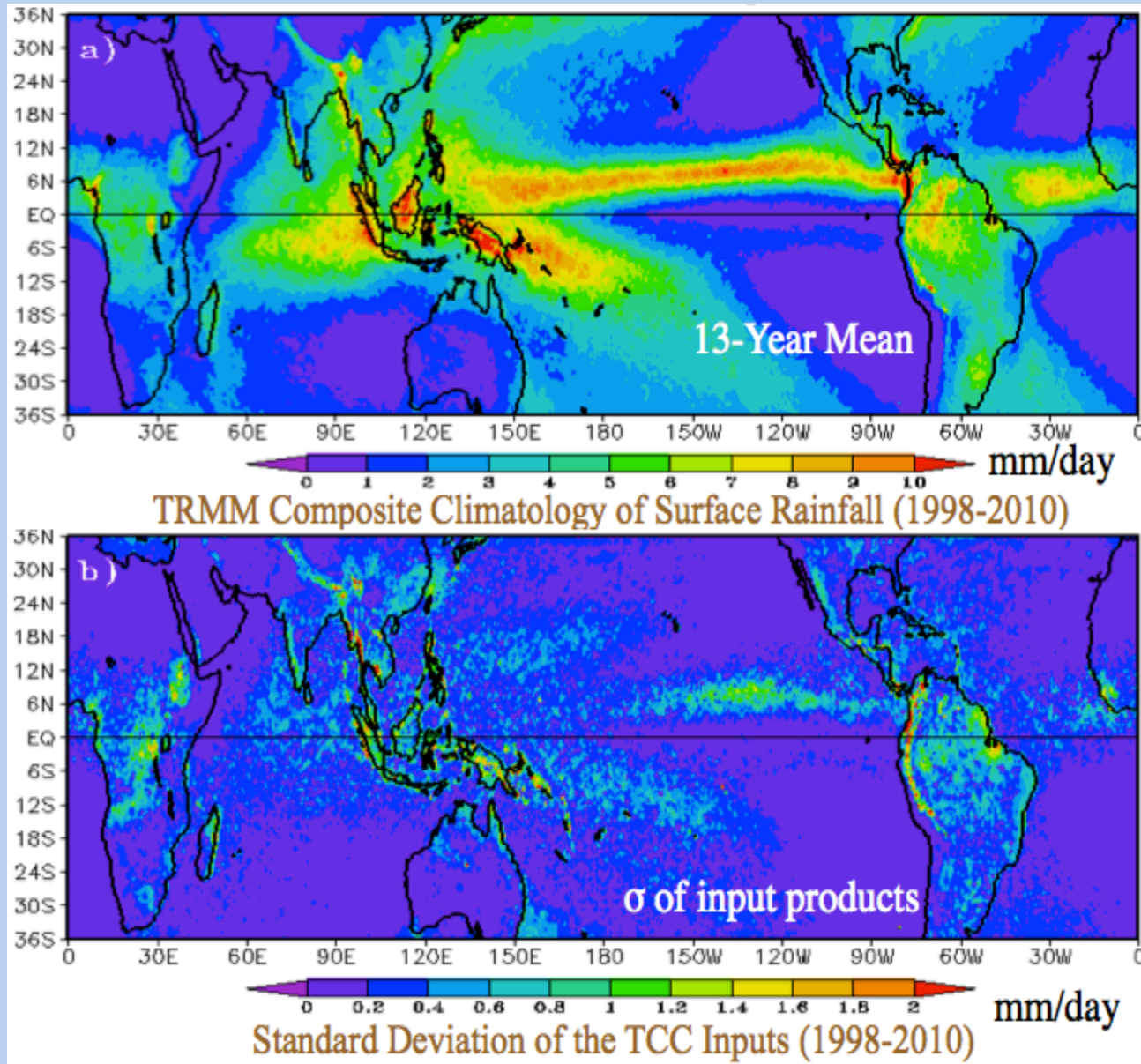
- 1) TMI (2A12)
- 2) PR (2A25) [Near Surface — adjusted for boost]
- 3) Combined (2B31)

Land:

- 1) PR (2A25) [Near Surface — adjusted for boost]
- 2) Combined (2B31)
- 3) Multi-satellite with gauges (3B43)*

*** Preferred to use 2A12; hopefully in next TCC version with Version 7 2A12**

Thirteen-year (1998-2010) TRMM Composite Climatology (TCC)



Climatological value is mean of three input products at each 0.5 lat./long. grid

Standard deviation (σ) among the three products is an estimate of error—note E. Pac. peak values ($\sigma/\text{mean} = 1.3/9 = 14\%$)

Tropics (25N-25S) Precipitation



		Total	<u>Ocean</u>	Land
25°S–25°N	2A12(ocean)/3B43(land)	2.95	2.88	3.15
	2A25-NS	2.96	2.97	2.94
	2B31	3.14	3.11	3.22
	TCC	3.02	<u>2.99</u>	3.09
	σ of TCC components	0.10	0.11	0.14

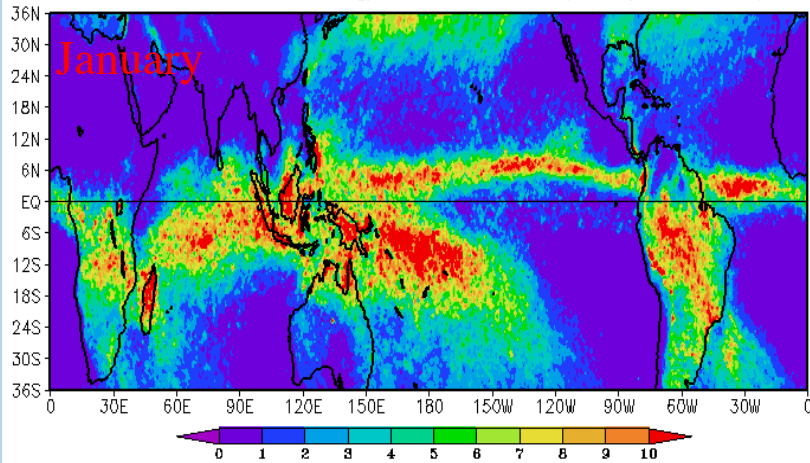


TCC = 2.99 mm/d +/- 4% ($\sigma/\text{mean} = .11/2.99 \sim 4\%$)

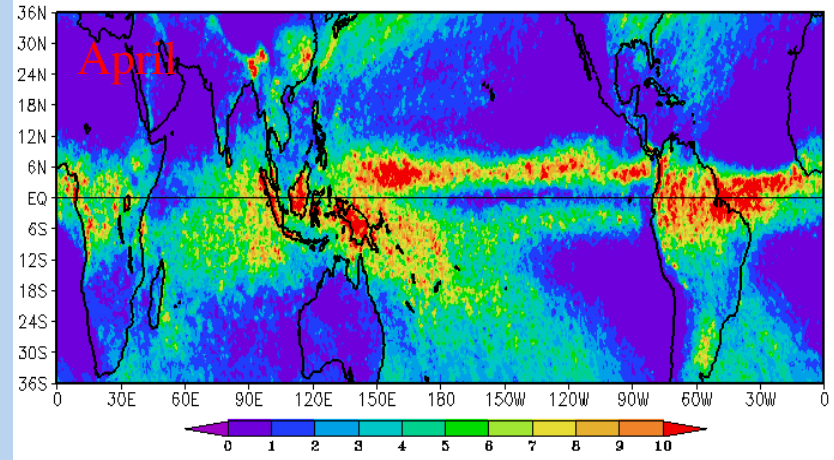
Bias Error Estimate may be an underestimate due to lack of independence among estimates

Seasonal Variation of TRMM Composite Climatology

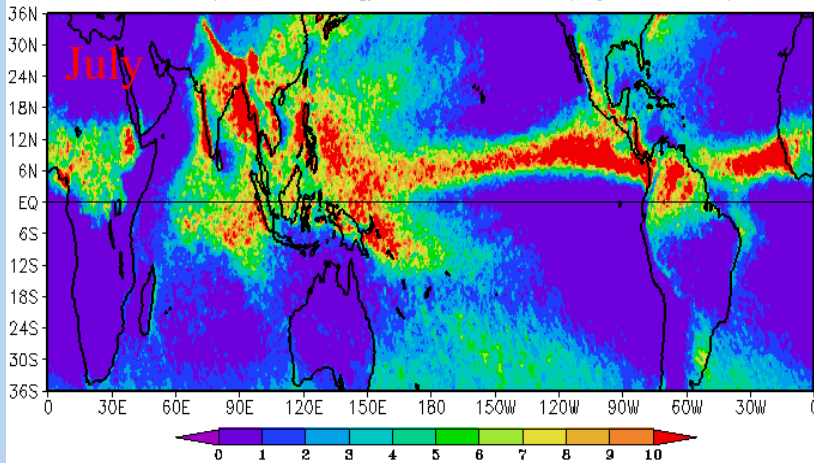
TRMM Composite Climatology of Surface Rainfall (January, 1998–2010)



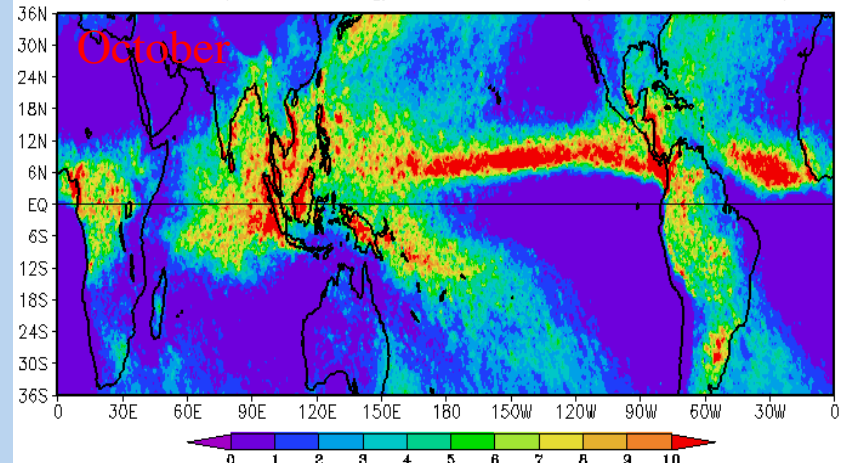
TRMM Composite Climatology of Surface Rainfall (April, 1998–2010)



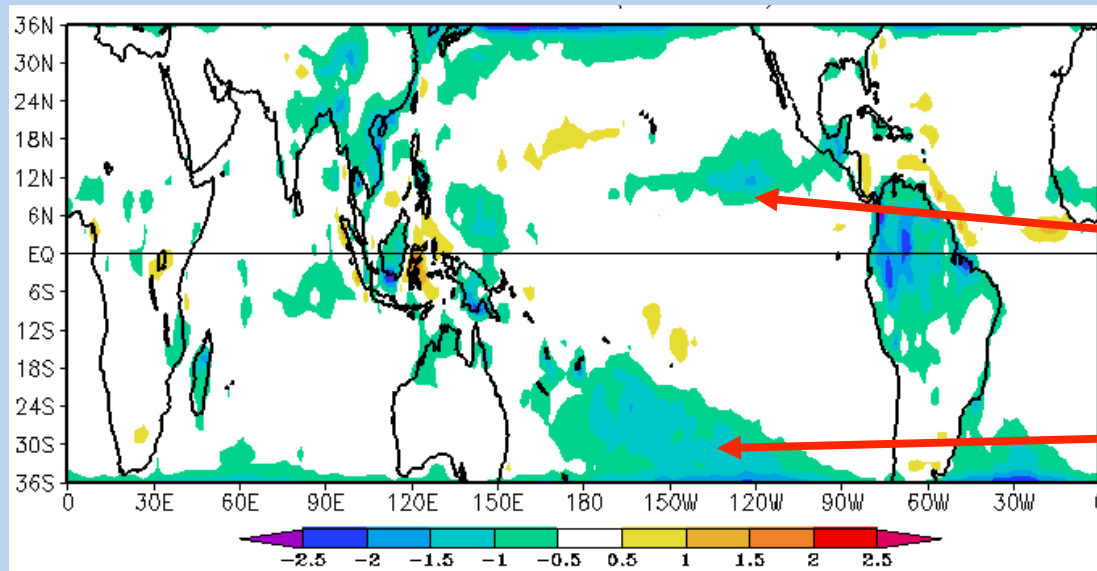
TRMM Composite Climatology of Surface Rainfall (July, 1998–2010)



TRMM Composite Climatology of Surface Rainfall (October, 1998–2010)



TCC Compared to GPCP (1998-2010)



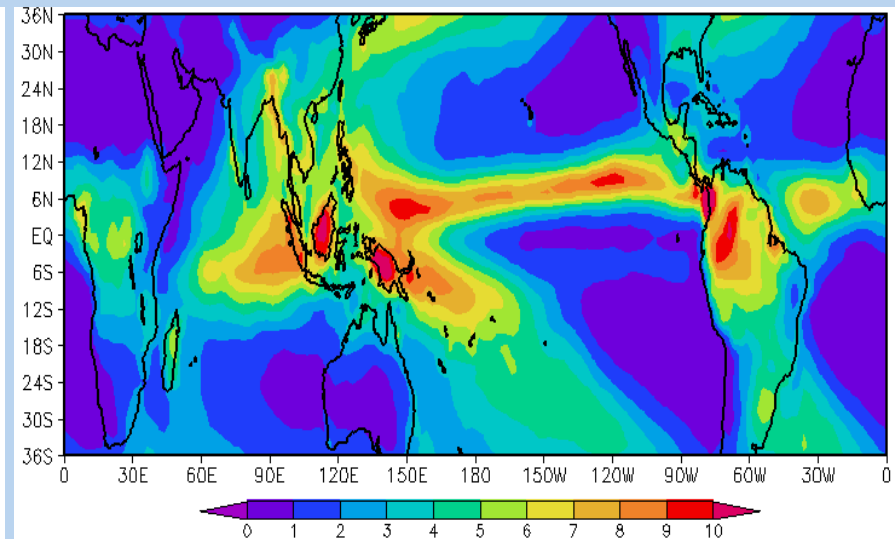
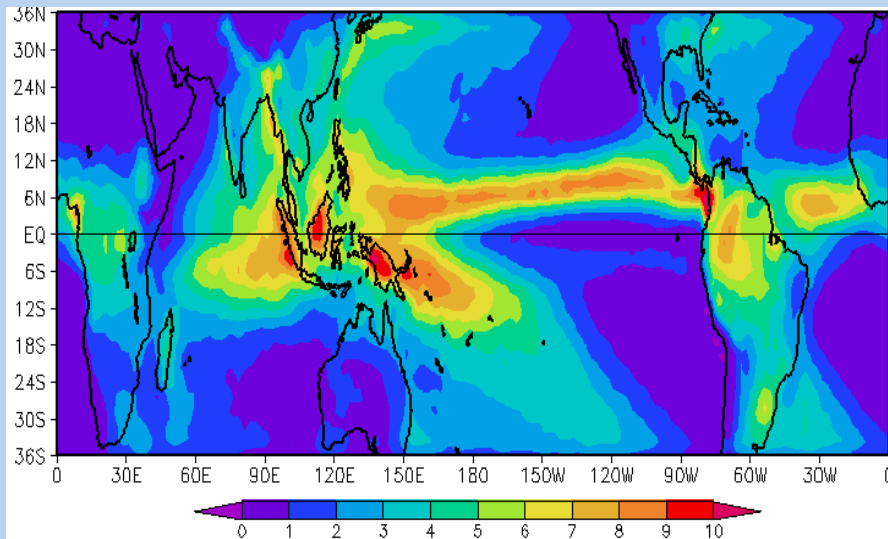
TCC-GPCP

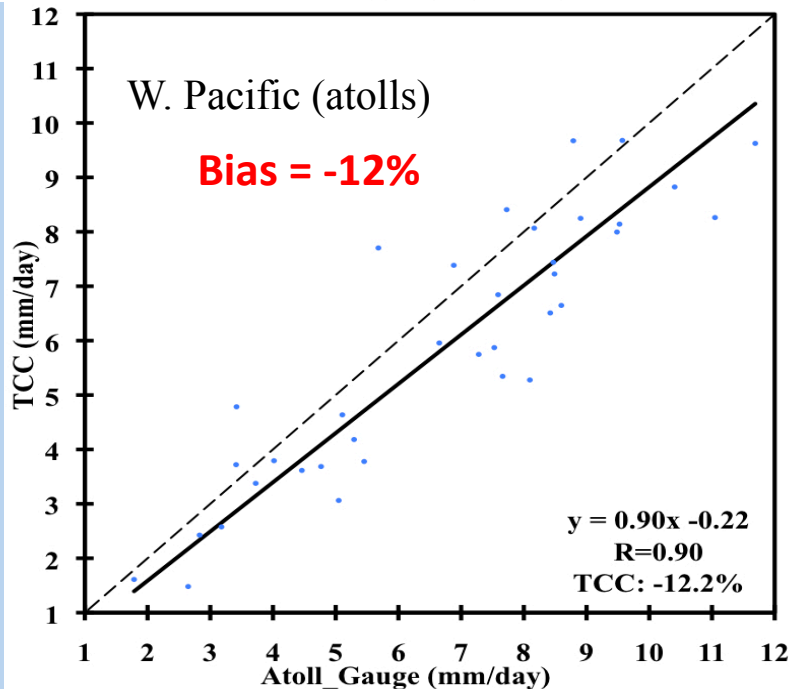
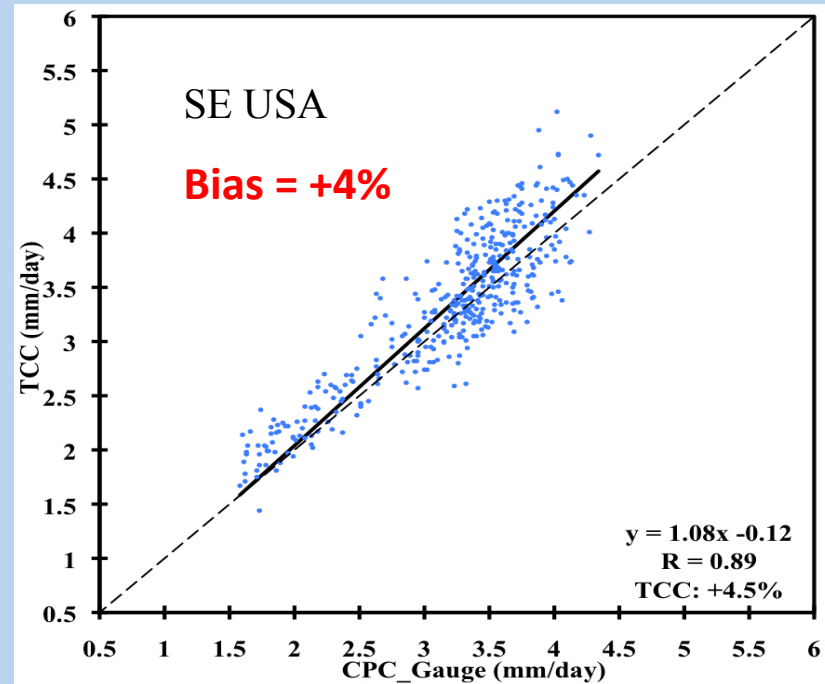
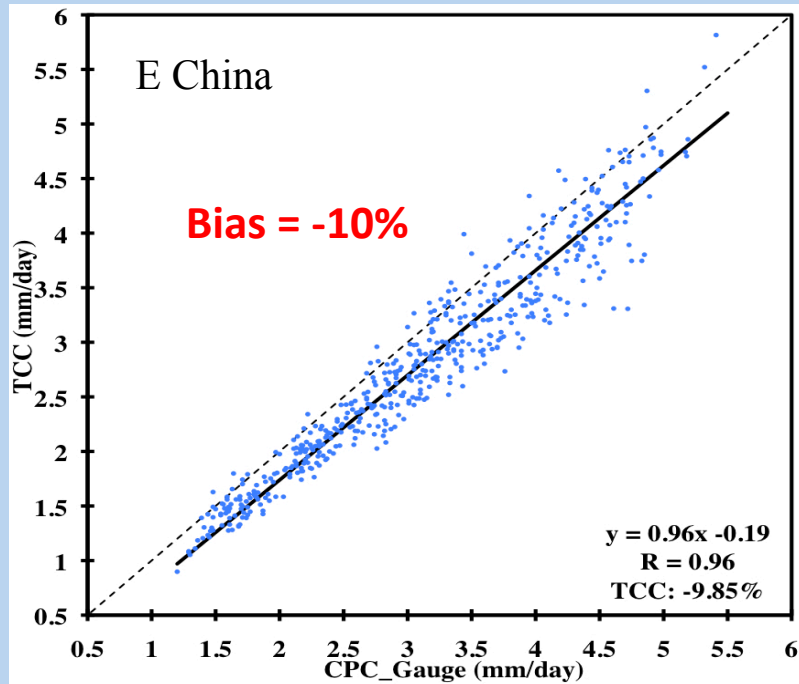
**1 mm/d out of
~6 mm/d
(17%)**

**1.25 mm/d out
of ~5 mm/d
(25%)**

TCC (smoothed to 2.5°)

GPCP

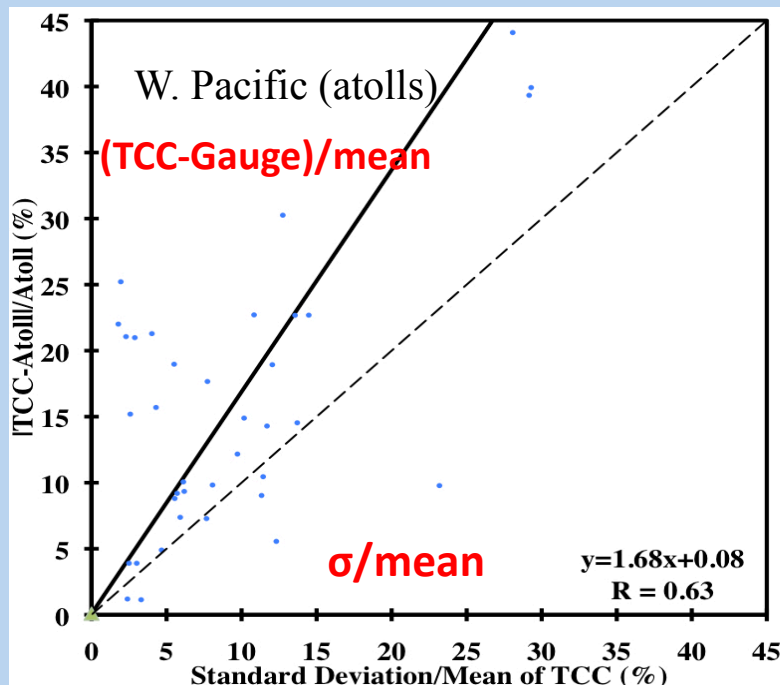
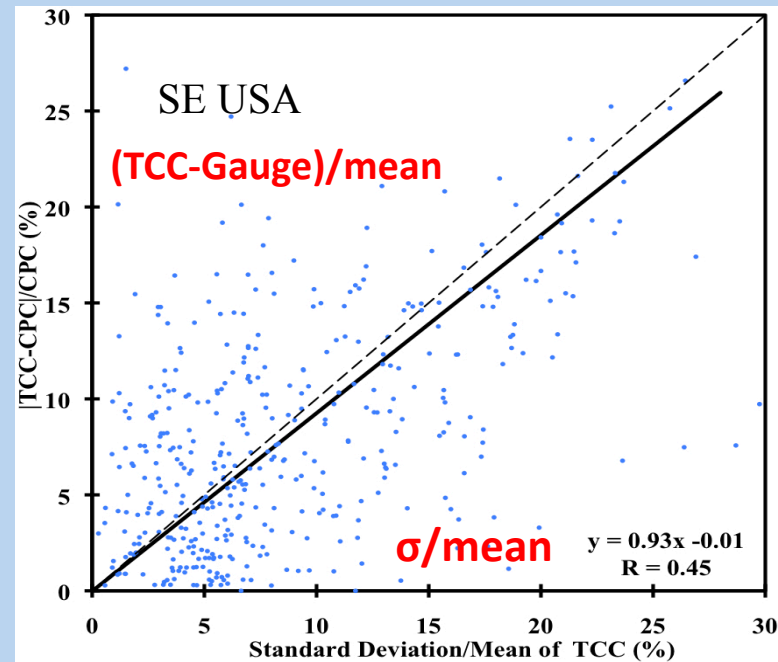
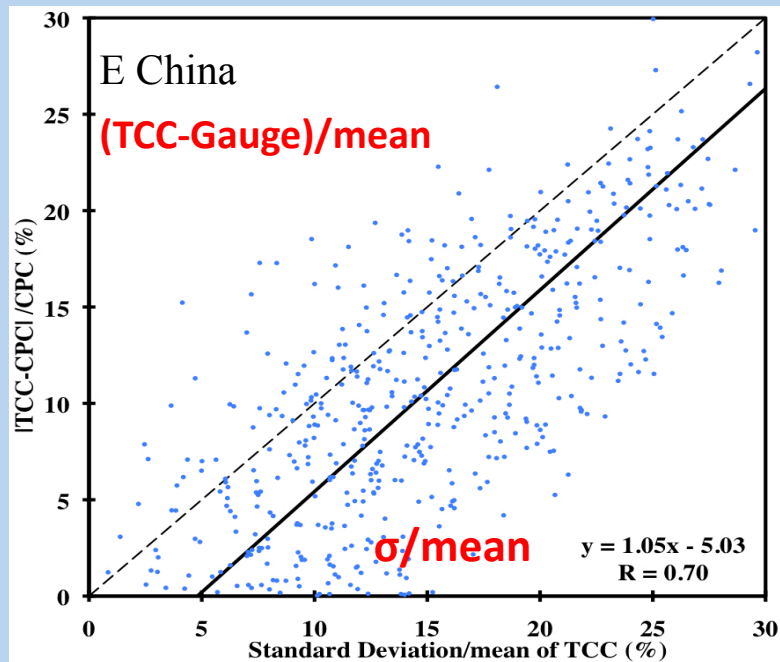




13-Year TCC vs. Gauges

Annual TCC climatology compared to quasi-independent gauge analyses at 0.5 degree resolution (TCC over land has one input product [3B43] that contains gauges)

Comparison with gauges indicate that TCC within margin of observational error



“Validation” of Estimated Bias Relative Error σ /mean vs. (TCC- gauge)/mean

Comparisons have large scatter, but in general larger σ is correlated to larger “error” (difference from gauge)

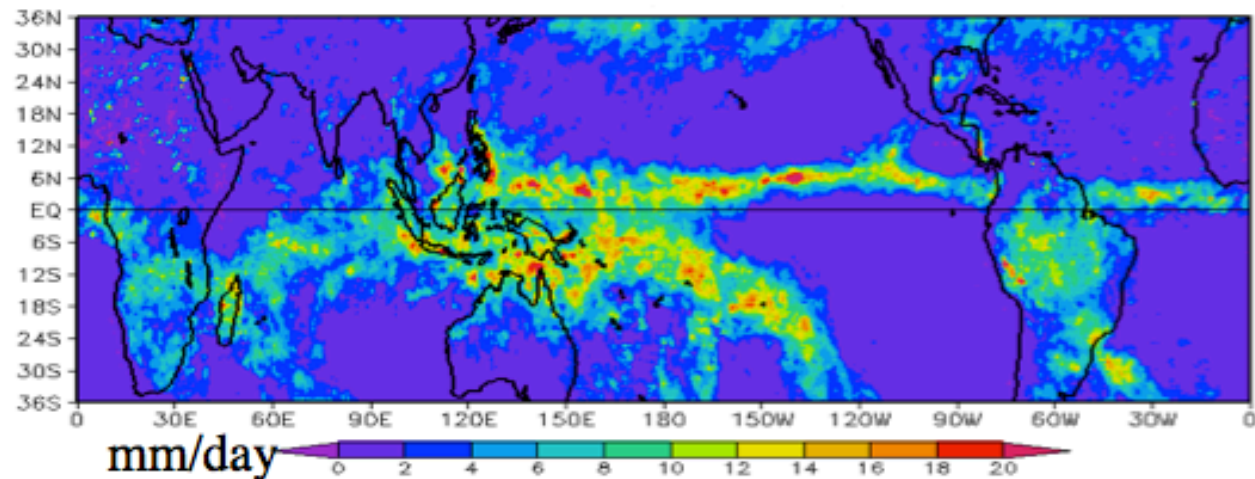
Over China and U.S. slope of relation is ~ 1 ; over W. Pac. atolls slope is ~ 1.7

These initial comparisons indicate that the σ among TRMM estimates has value as estimate of error, at least in a relative sense and perhaps in terms of absolute value

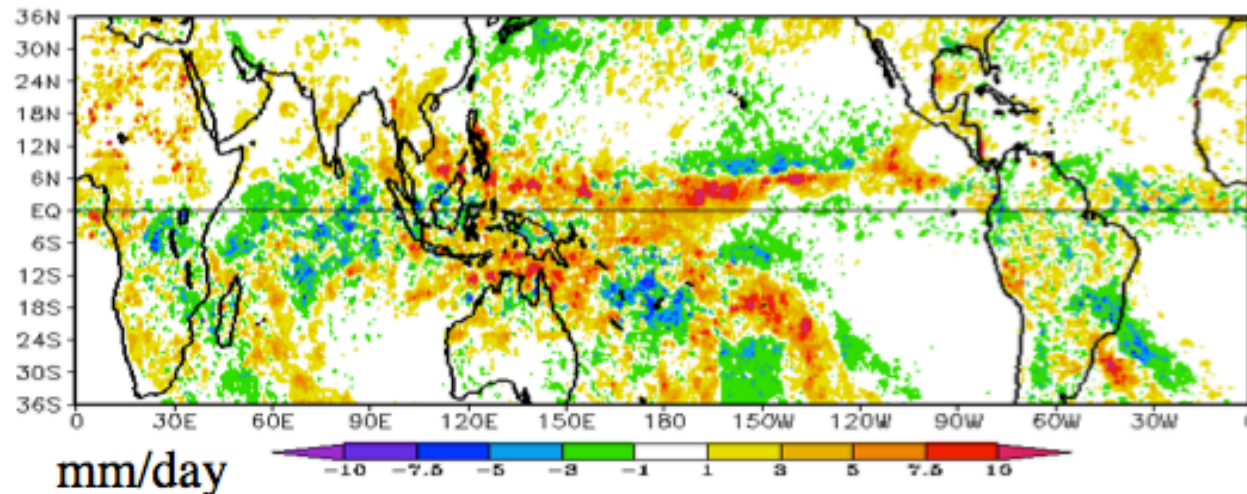
New TRMM Composite Products at Monthly Scale

TRMM Composite Monthly (TCM): Composites of three TRMM products are produced for 3-month running means at 2.5° lat.-long. to obtain sufficient sampling and avoid aliasing. Results are then disaggregated in time (down to a month) and space (0.5°) using 0.25° TMPA (3B43) to produce TCM. TRMM Composite Anomaly (TCA) is TCM minus TCC for month.

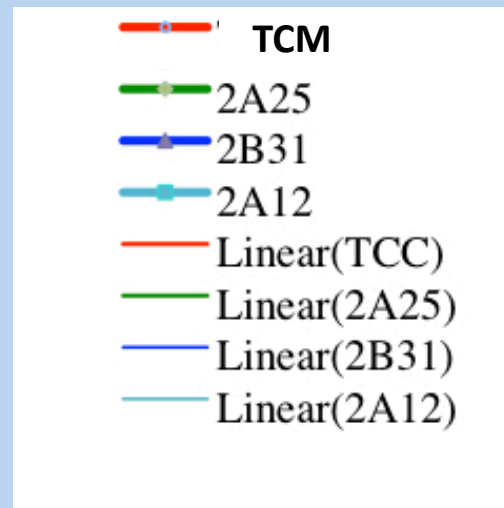
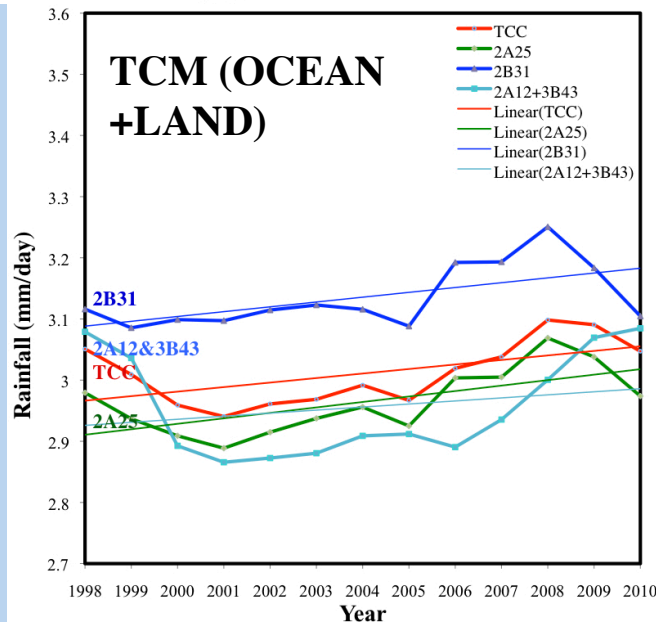
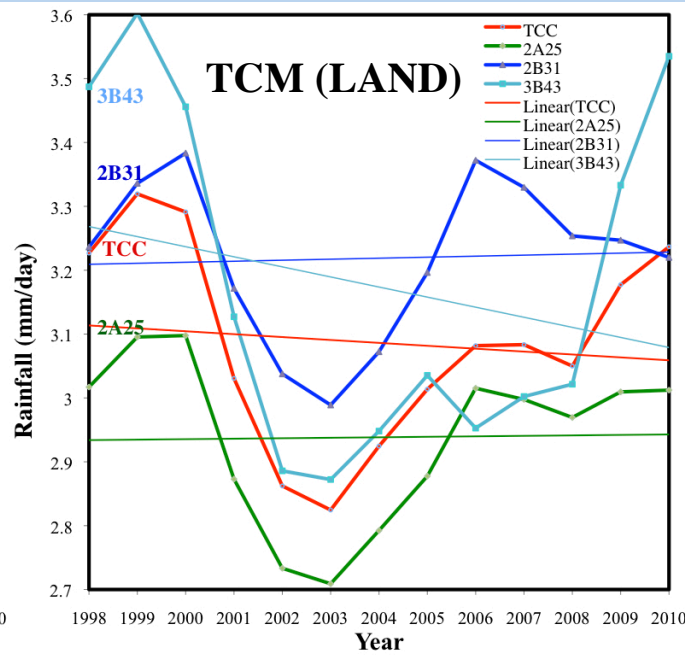
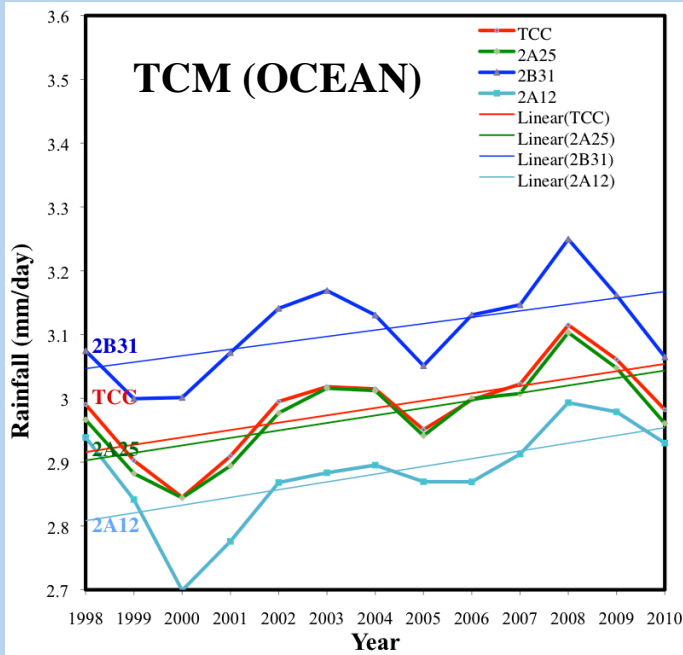
**TRMM Composite
Monthly (TCM)
for
January 2010**



**TRMM Composite
Anomaly (TCA)
for
January 2010**



TCM annual totals for TRMM's 13 years, plus input fields



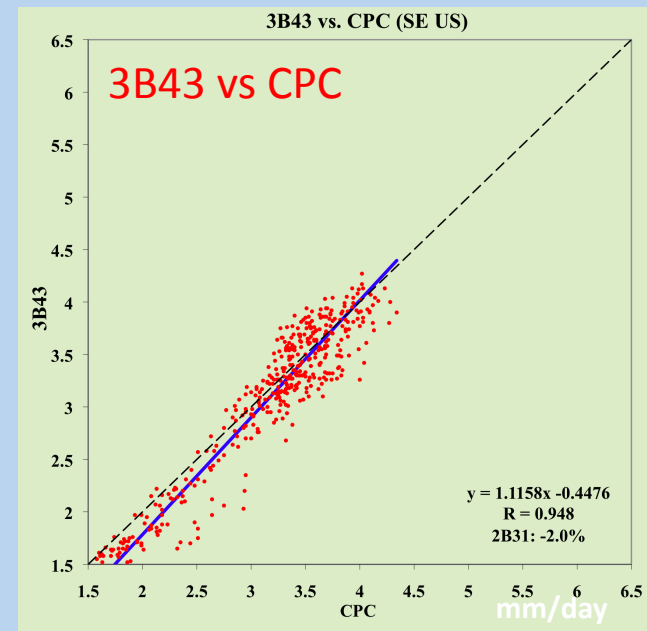
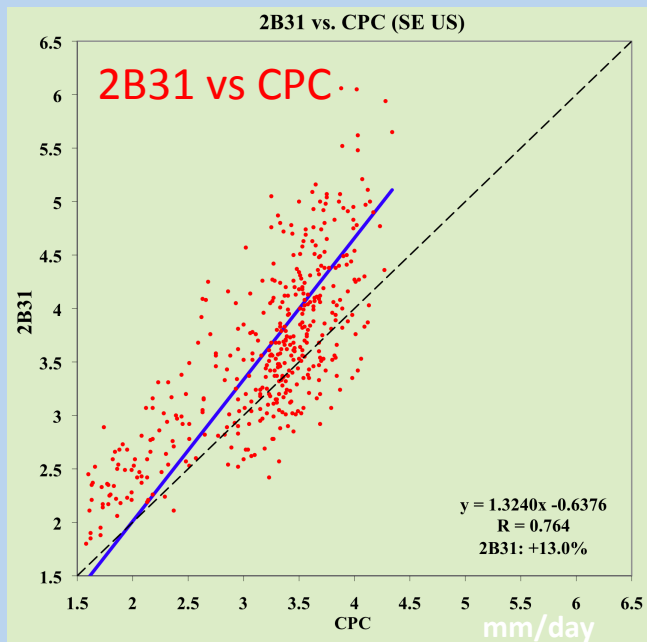
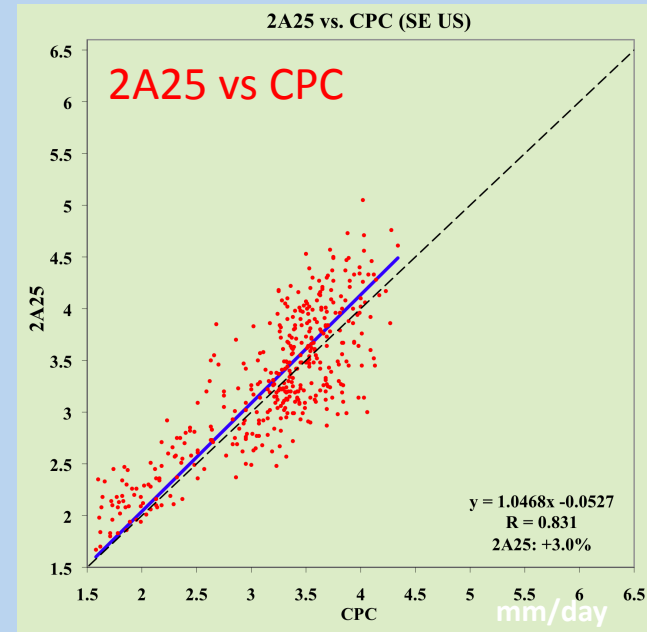
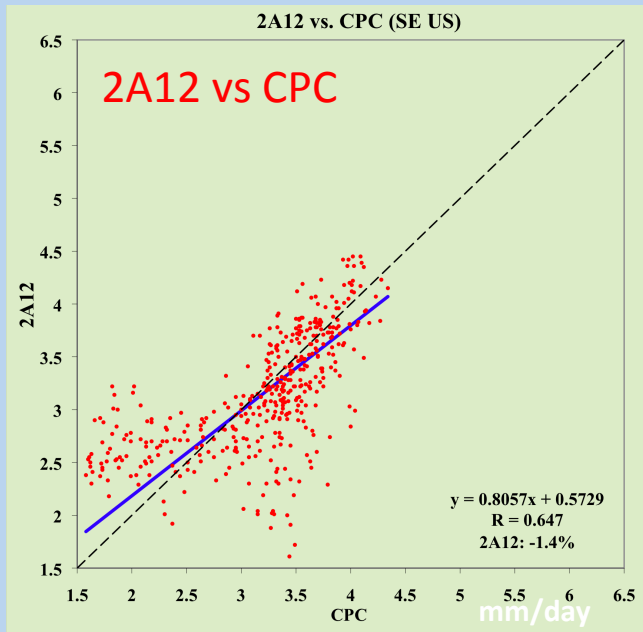
Summary

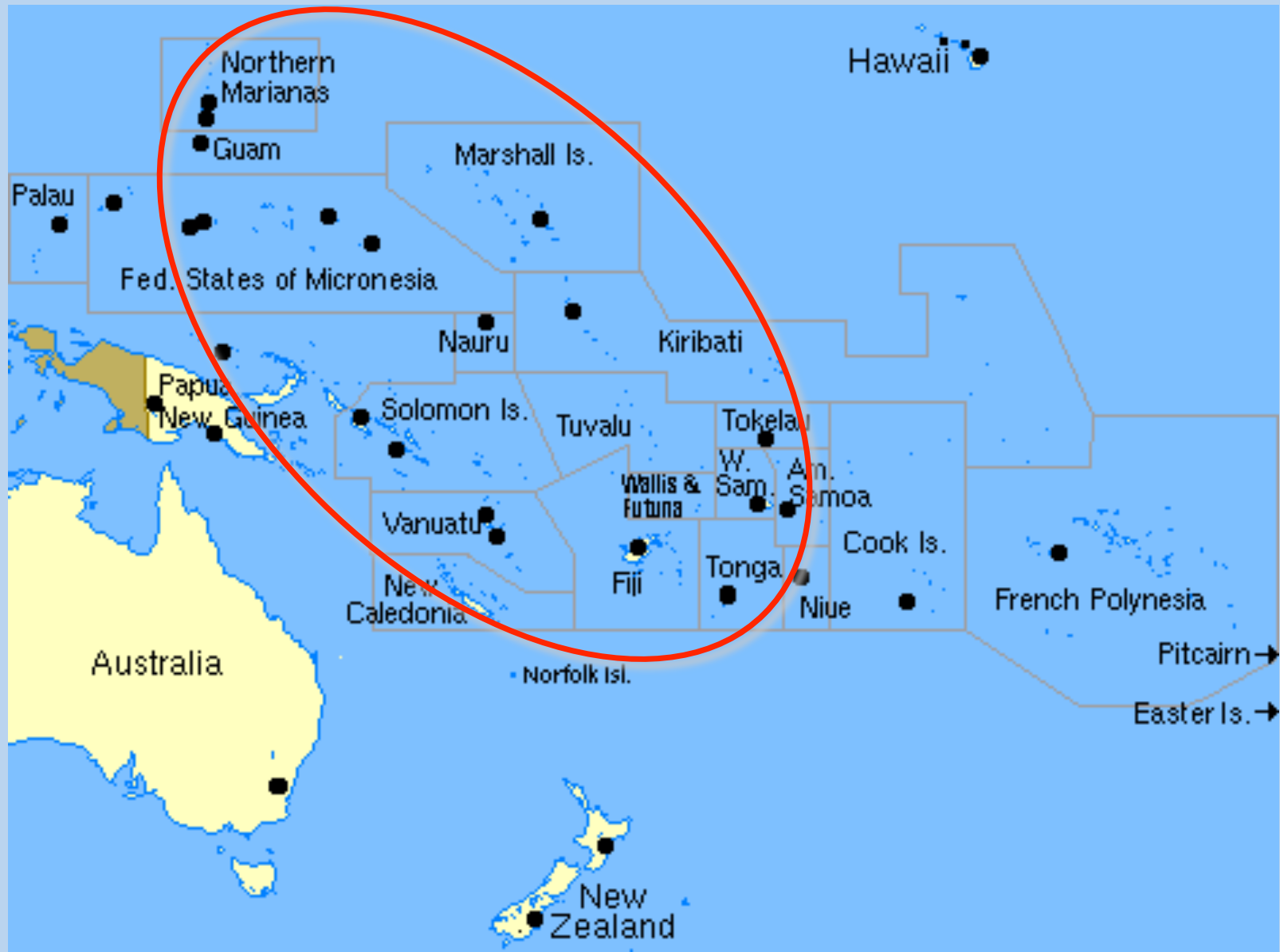
- A TRMM Composite Climatology (TCC) of surface rainfall has been developed and updated through 2010 with a selection of Version 6 products and also eliminating artifacts, accounting for boost and using the variance among products as an estimate of bias error. Comparison with gauges indicates TCC within reasonable bounds.
- Standard deviation of TCC inputs is a measure of dispersion and an estimate of bias error. This error estimate is correlated with actual bias error (as determined by gauge validation data). Error technique can be used to provide bias error estimates for individual locations, zonal means and tropics as whole, but needs to be improved by taking into account non-independence of estimates.
- New TRMM Composite Monthly (TCM) provides monthly estimates constrained by TRMM estimates, minimizing aliasing effects and using TMPA (3B43) only for disaggregation.
- TCC and TCM do not replace individual estimates/products, but provide easy to use TRMM estimates of climatology and monthly estimates for wide outside community—e.g., from global modelers to middle school students.

TCC presently available on PPS website and TCC and TCM will hopefully be available soon through Goddard DISC

Future Work

- TCC will be updated with TRMM Version 7, after careful examination/validation of product results. The new TCC will hopefully use 2A12 over land.
- Using dispersion of product values as estimate of bias error has limitations, but will be improved and continue to be validated against actual errors
- TRMM Composite Monthly (TCM) fields and their anomalies from climatology will also be validated to ensure their usefulness for climate variation studies during the TRMM era.
- TCM data and the input fields will be studied to determine variations in ENSO, relation to surface temperature and water vapor changes and how the TRMM era fits into the last 30 years of satellite estimates.
- The Global Precipitation Climatology Project (GPCP) of WCRP/GEWEX is updating its global analysis and the GPCP group is working to integrate TRMM information, possibly in terms of TCC into GPCP. And GPM will soon be available to continue and expand this effort.

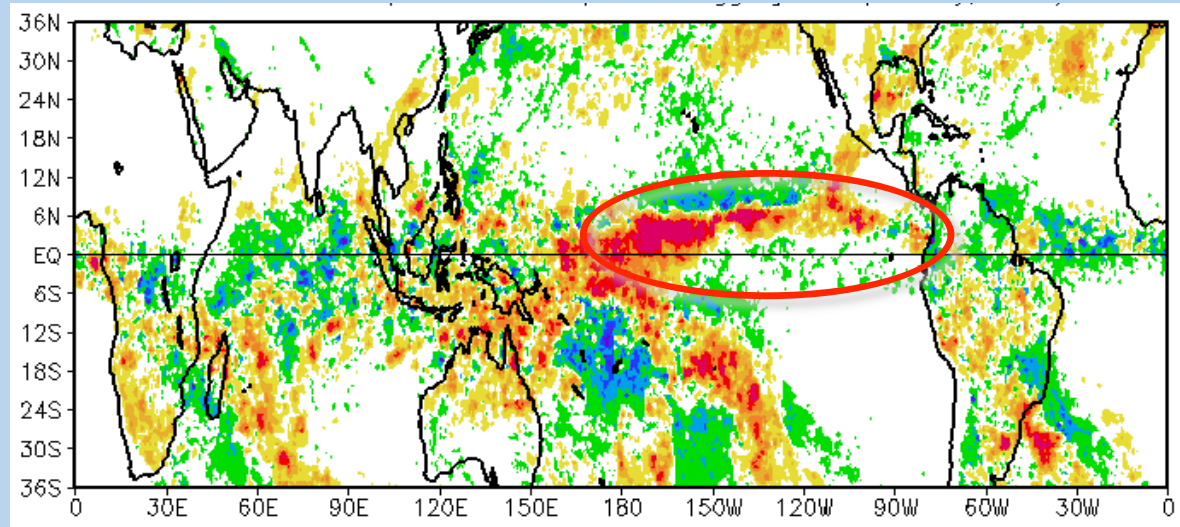




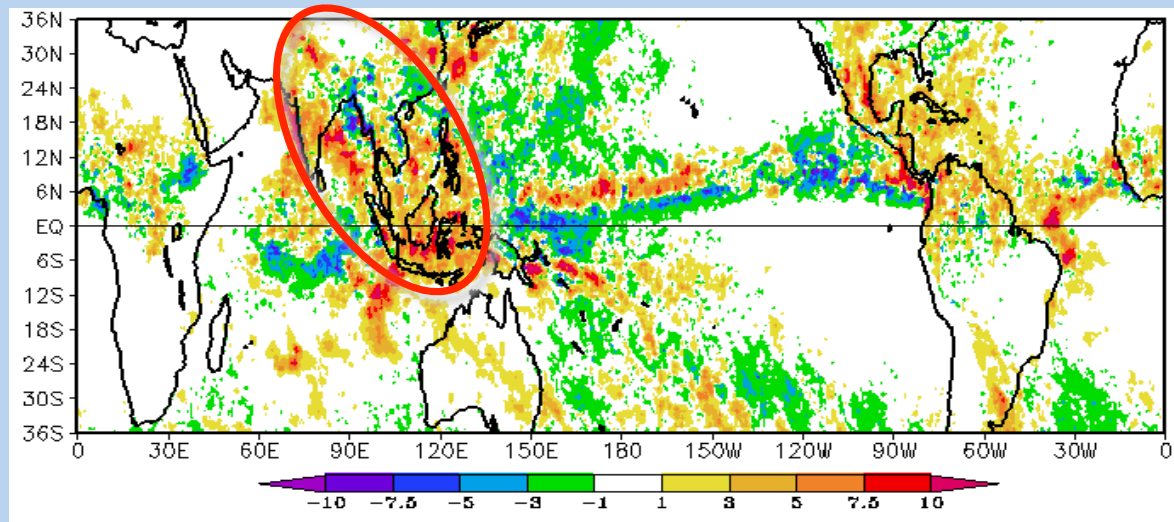
		Total	Ocean	Land
22.5°-35° S/N	2A12(ocean)/3B43(land)	1.84	1.97	1.53
	2B31	1.82	1.92	1.59
	2A25-NS	1.85	2.03	1.46
	TRMM Composite	1.83	1.97	1.53
	GPCP	2.12	2.37	1.61
10°-22.5° S/N	2A12(ocean)/3B43(land)	2.17	2.13	2.30
	2B31	2.36	2.38	2.31
	2A25-NS	2.23	2.27	2.12
	TRMM Composite	2.25	2.26	2.24
	GPCP	2.46	2.41	2.57
10°S-10°N	2A12(ocean)/3B43(land)	4.24	4.08	4.77
	2B31	4.48	4.33	4.95
	2A25-NS	4.22	4.13	4.48
	TRMM Composite	4.30	4.18	4.73
	GPCP	4.55	4.28	5.34

TRMM Composite Anomalies (TCA)

January, 2010



July, 2010



Deep Tropics (10N-10S) Ocean Precipitation



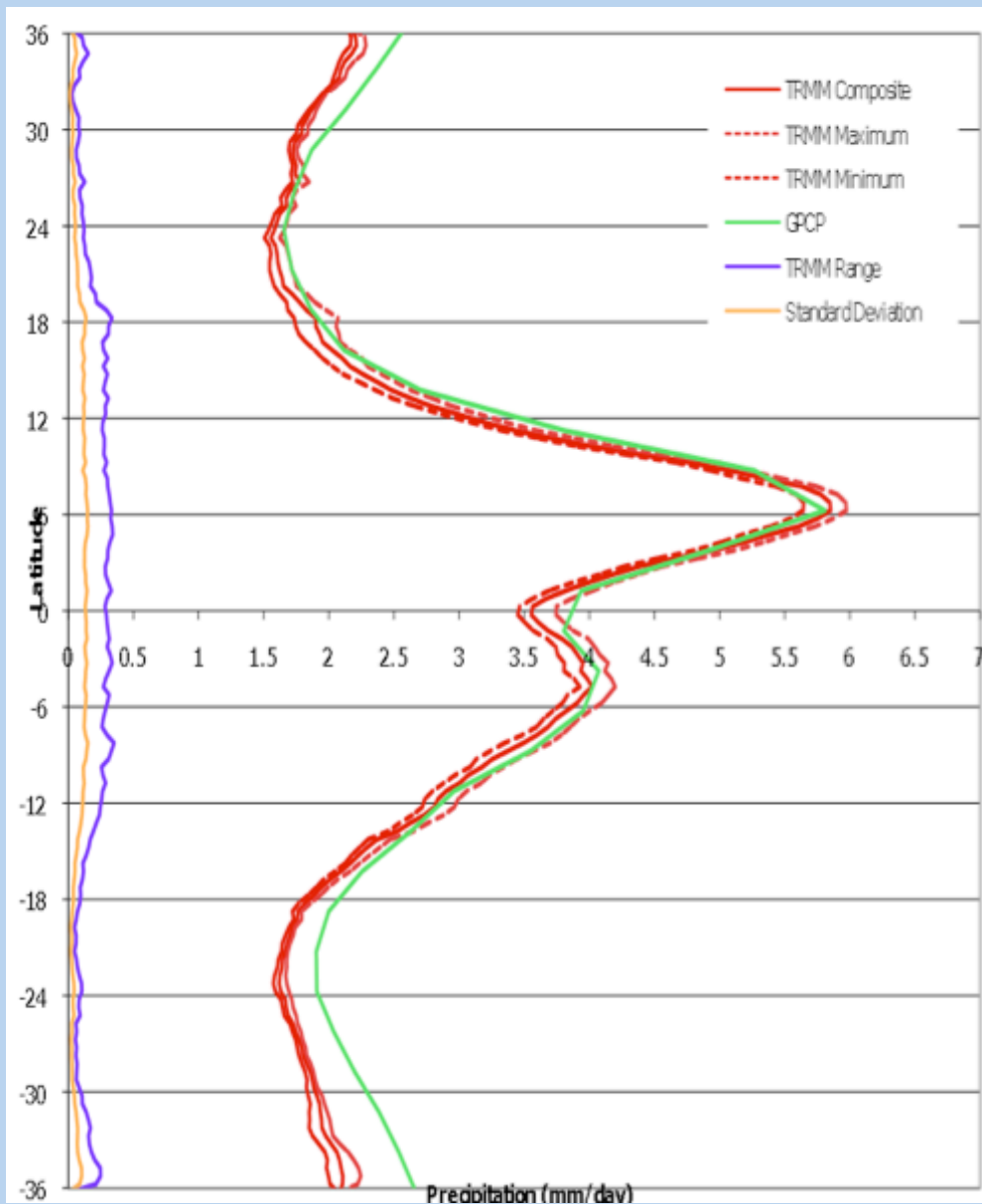
		Total	Ocean	Land
10°S–10°N	2A12(ocean)/3B43(land)	4.24	4.08	4.77
	2B31	4.48	4.33	4.95
	2A25-NS	4.22	4.13	4.48
	TRMM Composite	4.30	4.18	4.73
	GPCP	4.55	4.28	5.34



TCC = 4.18 mm/d +/- 3% ($\sigma/\text{mean} = .12/4.18 \sim 3\%$)

Bias Error Estimate an underestimate due to lack of independence

TCC Zonal Means and Comparison to GPCP Over Ocean



Zonal mean at peak (7°N)
6.5 mm/d +/- 3%

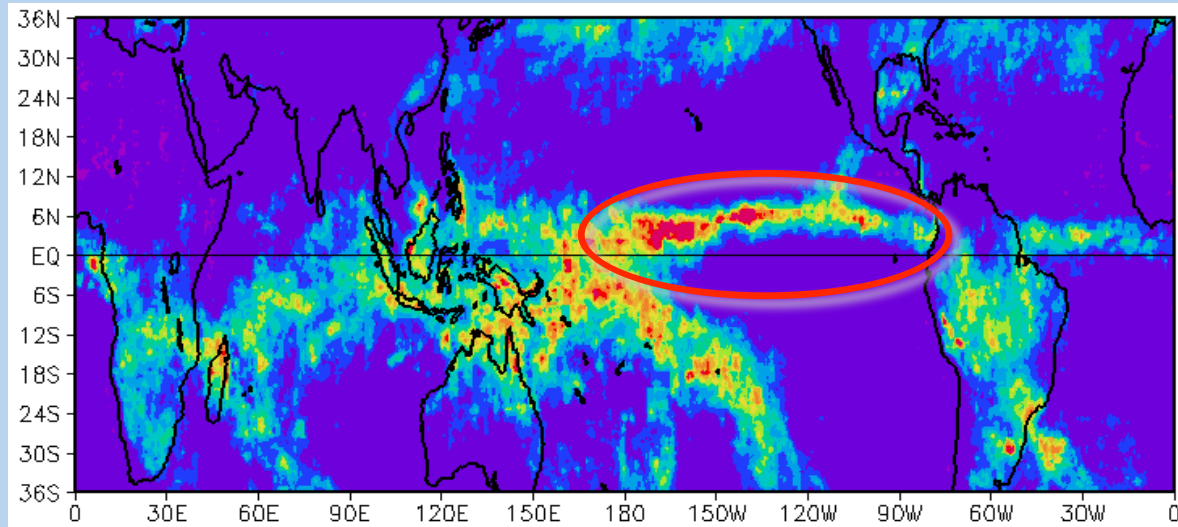
Zonal mean at 6°S
3.6 mm/d +/- 5.5%

Zonal mean at 23°N
1.7 mm/d +/- 9%

TCC ocean climatology confirms GPCP values in deep Tropics; indicates difference in sub-tropics into mid-latitudes

TRMM Composite Monthly (TCM) Rainfall

January, 2010



July, 2010

