TMI - PR comparisons as a function of rain rate, rain type and geographical region

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Purpose of this Study

Dissimilar to other comparative studies of examining the difference of zonally or regionally averaged values between the GPROF V.7 TMI and PR rain retrievals,

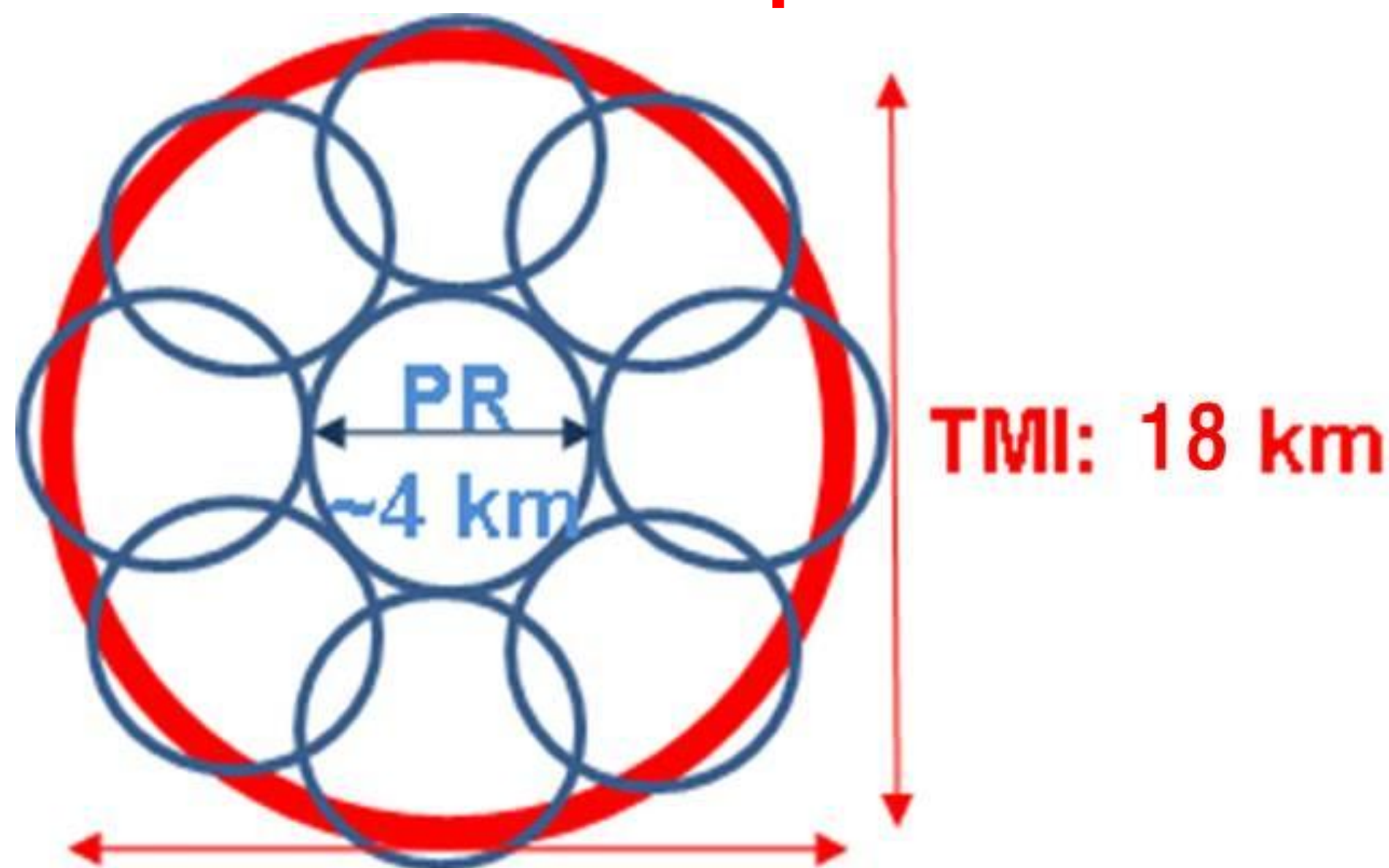we seek to study their difference as a function of

(1) rain rate,
(2) rain type, and
(3) geographical region.

Data

- Oceanic pixels of TMI and PR for 15-year JJAs between 1998 and 2012
- TMI and PR pixels were collocated by averaging PR rain rates over a nominal footprint (18 x 18 km^2) of TMI.
- Based on the convective areal fraction (convF), rain pixels are classified into one of the following three categories:
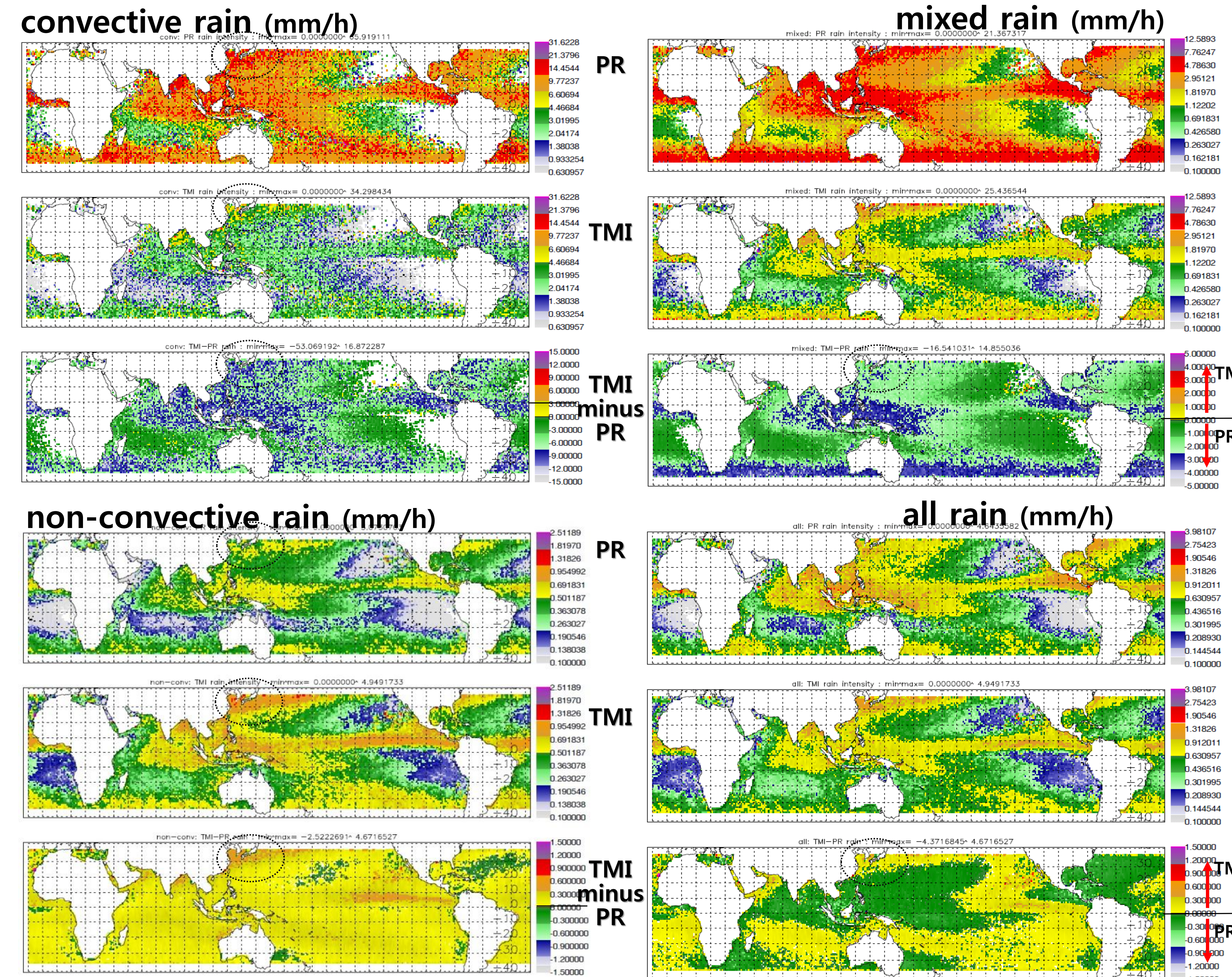
$$category = \begin{cases} 1 & 0.7 < convF \le 1.0 \\ 2 & , \text{ if } 0.3 < convF \le 0.7 \\ 3 & 0.0 \le convF \le 0.3 \end{cases}$$

mostly convective
mixed
non-convective

Nominal TMI footprint:

PR ~4 km
TMI: 18 km
TMI: 18 km

The schematic diagram of collocated pixels between TMI and PR.

Distribution of Mean Rain Intensity

convective rain (mm/h) — PR, TMI, TMI minus PR

mixed rain (mm/h) — PR, TMI, TMI minus PR

non-convective rain (mm/h) — PR, TMI, TMI minus PR

all rain (mm/h) — PR, TMI, TMI minus PR

Regional Variability of TMI-PR Difference
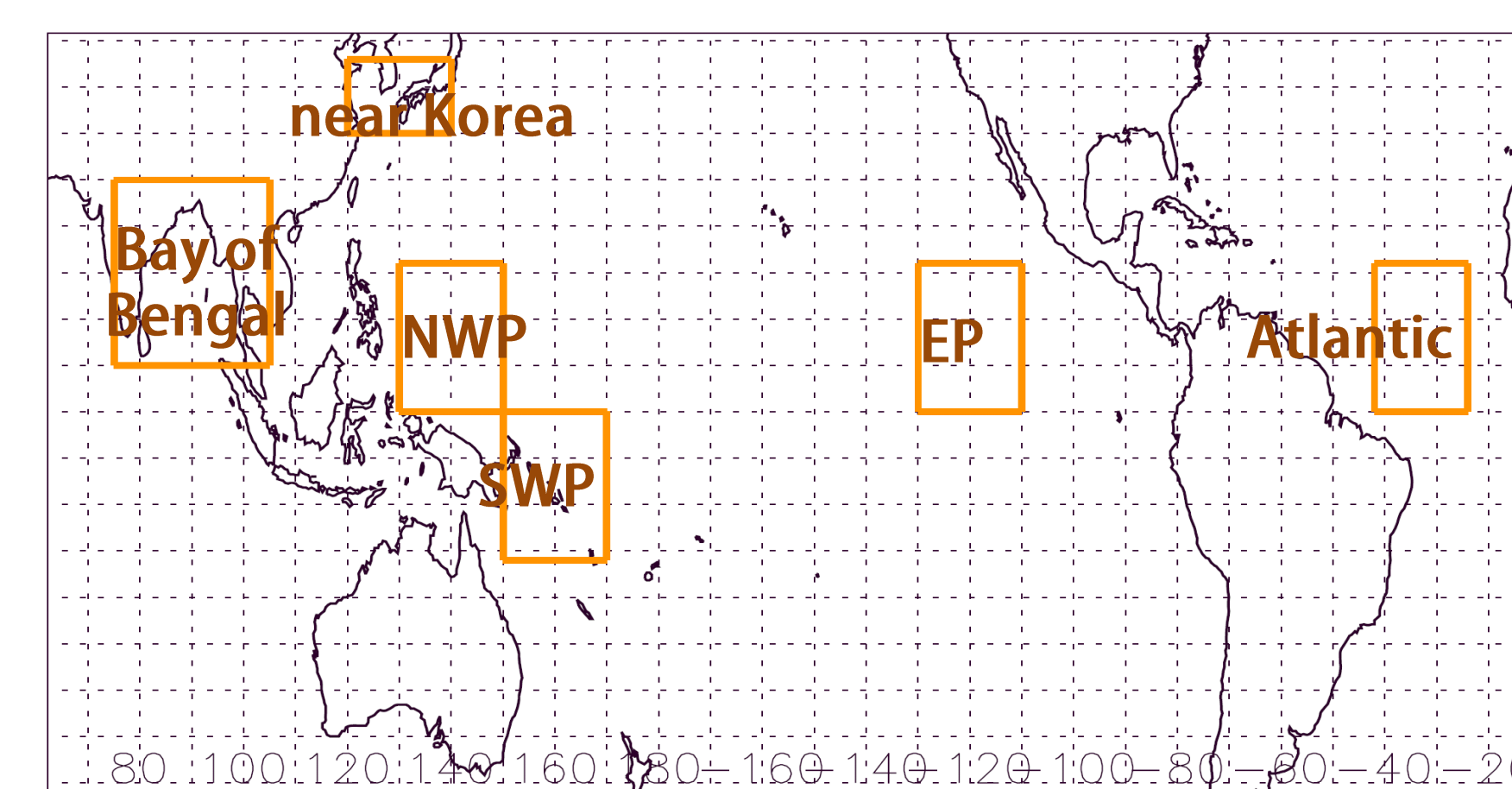
all rain (mm/h)

Region	near Korea	NWP	EP	Atlantic	Bay of Bengal	Global
Mean PR RR	0.95	0.92	0.76	0.91	0.98	0.67
Mean TMI RR	1.10	0.76	0.88	0.88	0.86	0.62
Bias (TMI – PR)	0.15 (+16%)	-0.16 (-17%)	0.12 (+16%)	-0.03 (-3%)	-0.12 (-14%)	-0.05 (-8%)
Mean difference	1.06	0.91	0.89	0.97	1.00	0.48

convective rain

Region	near Korea	NWP	EP	Atlantic	Bay of Bengal	Global
Mean PR RR	13.90 1.2%	11.06 0.8%	9.26 0.6%	10.62 0.7%	12.56 1.4%	10.02 0.6%
Mean TMI RR	4.94	2.70	2.55	2.60	3.87	2.70
Bias	-8.96 (-64%)	-8.36 (-76%)	-6.71 (-72%)	-8.02 (-76%)	-8.69 (-69%)	-7.32 (-73%)

mixed rain

Region	near Korea	NWP	EP	Atlantic	Bay of Bengal	Global
Mean PR RR	4.39 7.1%	4.11 8.3%	3.56 7.6%	3.84 8.9%	4.23 9.6%	3.16 7.4%
Mean TMI RR	2.30	1.41	1.54	1.44	1.75	1.15
Bias	-2.09 (-48%)	-2.70 (-66%)	-2.02 (-57%)	-2.40 (-63%)	-2.48 (-59%)	-2.01 (-64%)

non-convective rain

Region	near Korea	NWP	EP	Atlantic	Bay of Bengal	Global
Mean PR RR	0.51 91.7%	0.54 90.9%	0.48 91.8%	0.55 90.4%	0.45 89.0%	0.41 92.0%
Mean TMI RR	0.96	0.69	0.82	0.81	0.72	0.57
Bias	0.45 (88%)	0.15 (27%)	0.34 (71%)	0.26 (47%)	0.27 (60%)	0.16 (39%)

The numbers in green denote the frequency of occurrences for each rain type.

Spectral Difference btw TMI and PR Rain Rates

TMI minus PR Rain Rate — Convective, Mixed, Non-convective, Global

The difference (color pixels) in mm/h between TMI- minus PR-derived rain rate as a function of PR rain rate and convF. The soild lines represent the frequency of occurrences.

NWP

near Korea
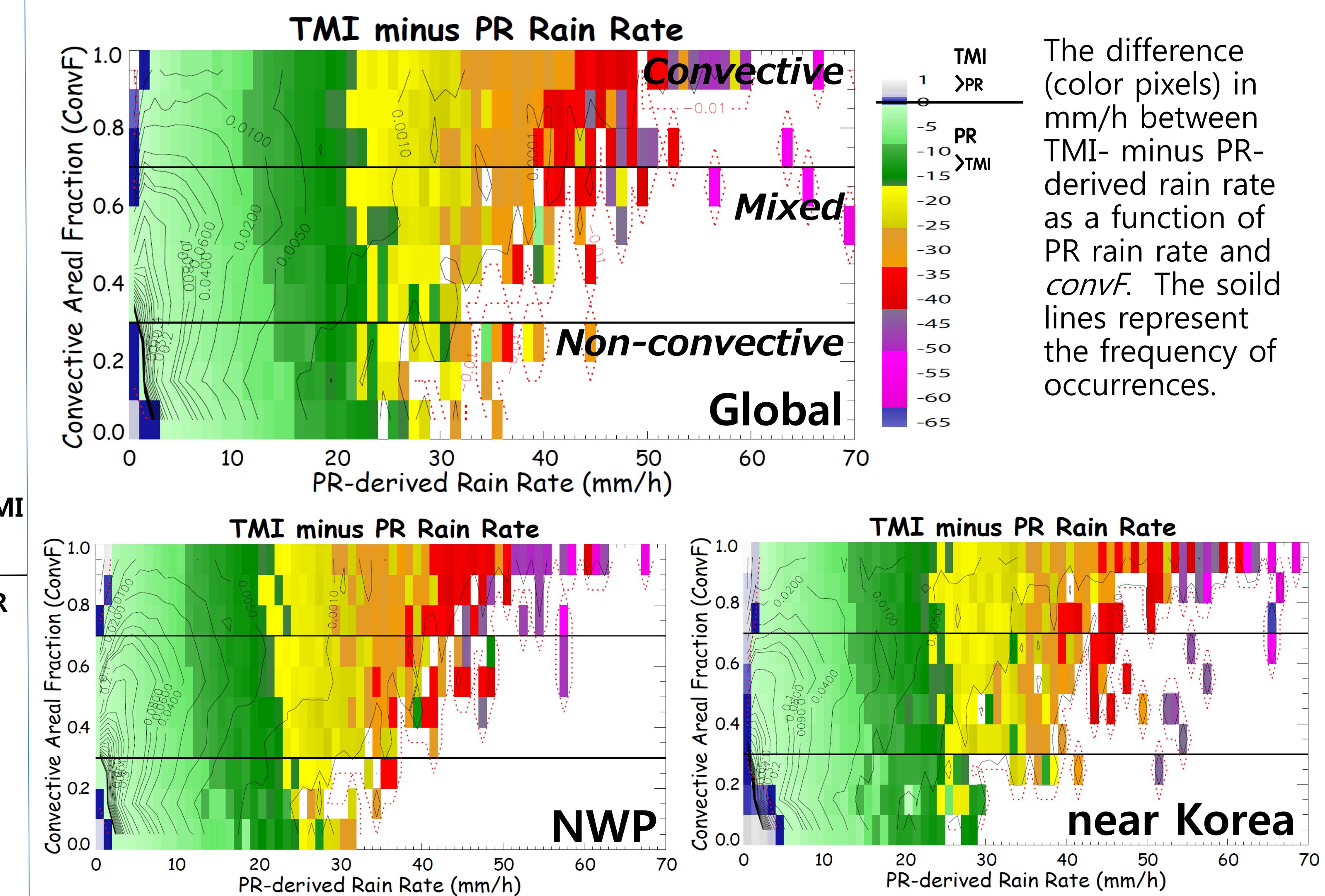
Summary

❑ In terms of mean rain intensity over the TRMM-covered region, the TMI-derived rain agrees well with the PR-derived rain (~8% difference).

❑ On the other hand, the estimates from the two instruments have very large and systematic differences as a function of the rain characteristics:

✓ The rain bias shows different sign depending on the region.

✓ In the convective rain category, TMI-derived RR < PR-derived RR.

✓ In the non-convective rain category, TMI-derived RR > PR-derived RR.

✓ The magnitude and sign of the rain bias appear to be a function of rain rates.

✓ Among the selected five regions, the largest positive bias in the TMI-PR difference is found in the vicinity of Korea due to the TMI-rain overestimation in non-convective rain compared to the other regions.