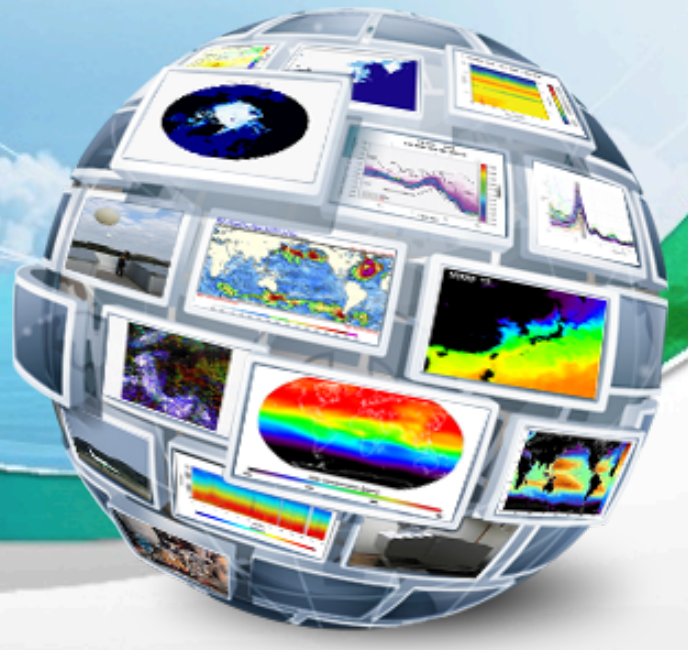
2013 NASA PMM Science Team Meeting, March 18-21, 2013, Annapolis, MD, USA

Current Status and Future Plan of Korean GPM Ground Validation Activity

Mi-Lim Ou[1]

G.-H. Ryu[1], E.-K. Seo[3], B.-J. Sohn[2], Mee-Ja Kim[1], and Ji-Hye Kim[4]



[1]National Institute of Meteorological Research, KMA, Korea
[2]Seoul National University, Korea
[3]Kongju National University, Korea
[4]Yonsei University, Korea

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Overview

- **Motivation/Background**
  - Heavy rain often occurred from warm clouds with no severe convective instability over the Korean peninsula other than that of US region.
  - It is necessary to examine current satellite-based precipitation retrieval algorithms in terms of regional dependency.

- **Joint activity with NASA on GPM GV since 2010**
  - Prototype S/W of GPM GV has been implemented over Korea.
  - It was tested with KMA GV data and GPROF V6 and V7 products.

- **To prepare for GV in Korea after the GPM launch**
  - Need to Implement routine exchange of GV data over Korea

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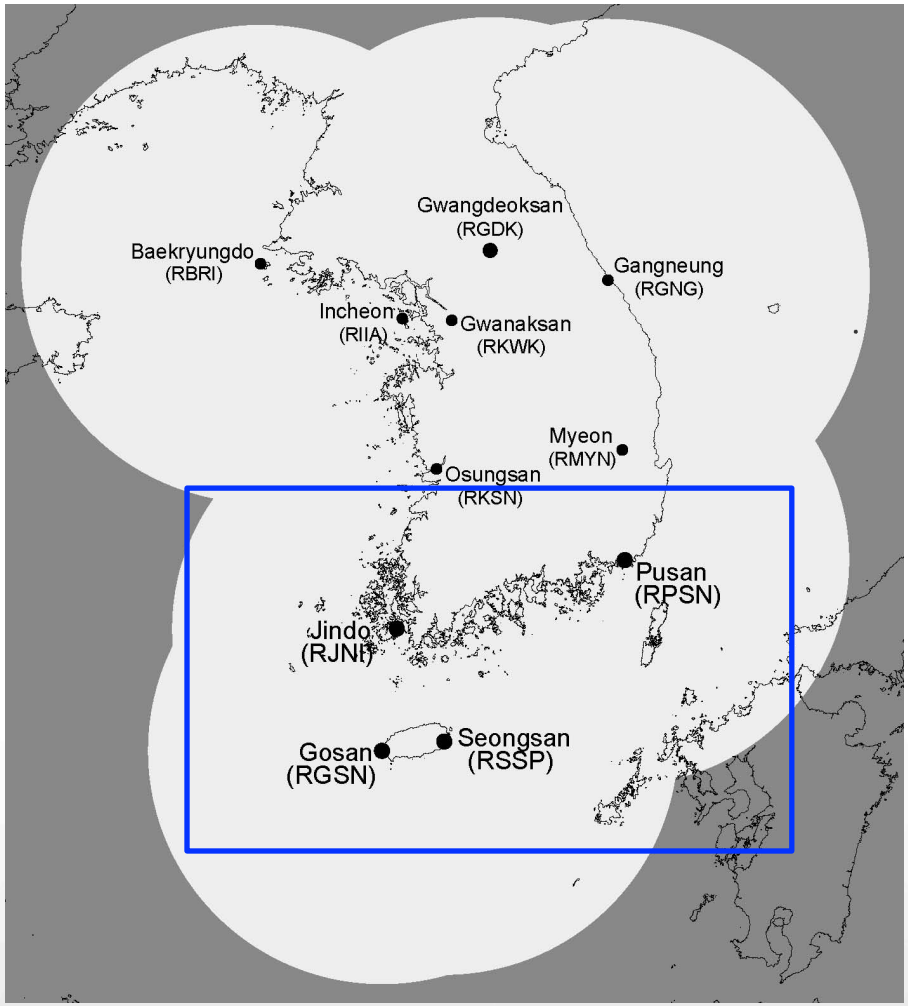
PART I:♪

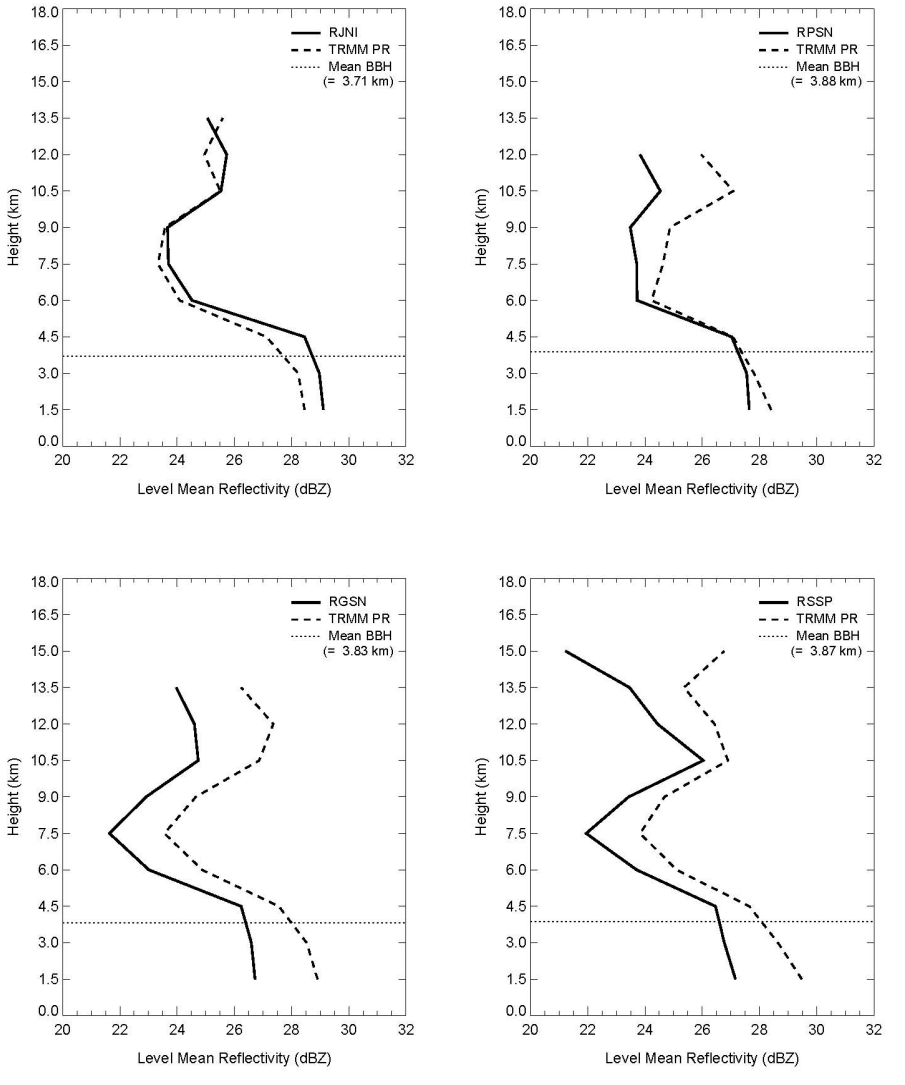
Statistical Validation of GPM GV S/W Using Ground-based Observations over the Korean Peninsula

Mi-Lim Ou, Ji-Hye Kim*
K. Morris** and M. Schwaller**

*Yonsei University
**NASA/GSFC

Layer-averaged Reflectivity





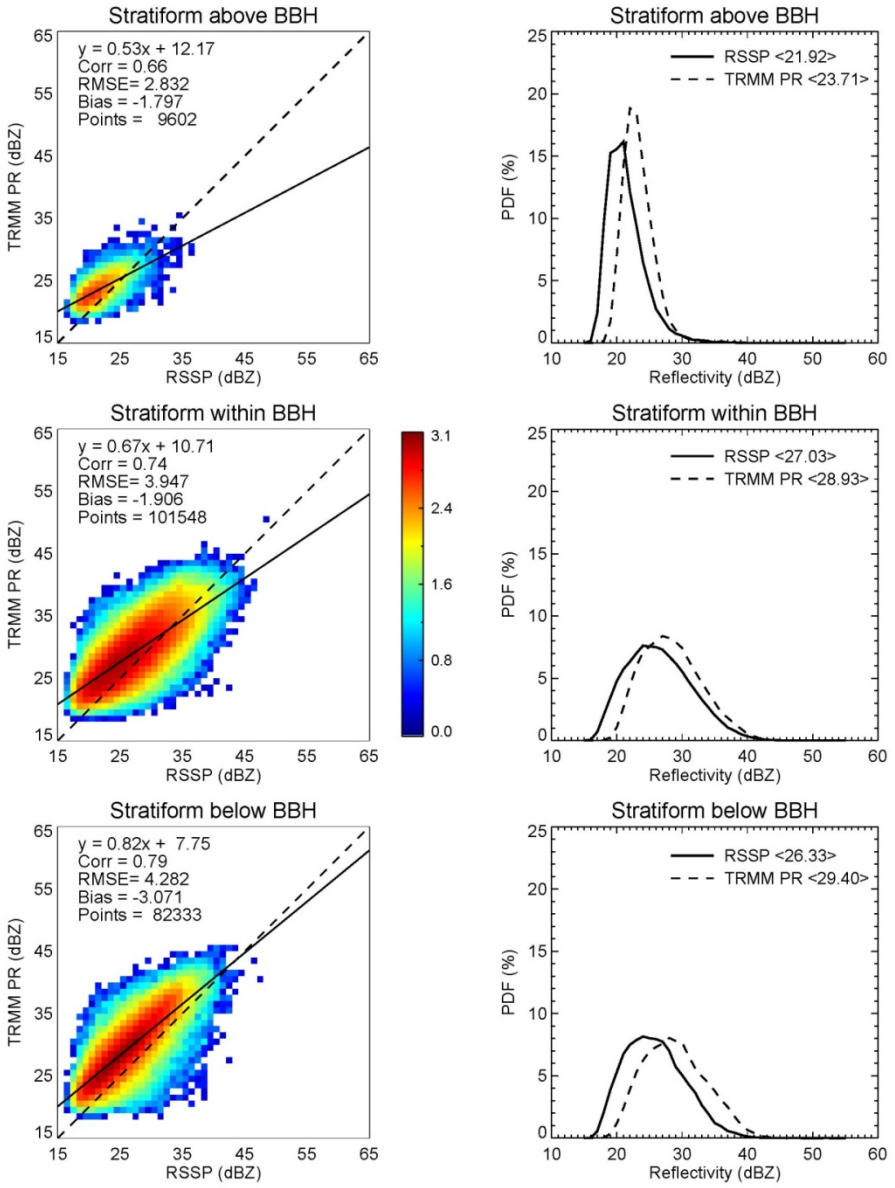
Mean Bias of (GR-PR) Reflectivity

For above BBH♪

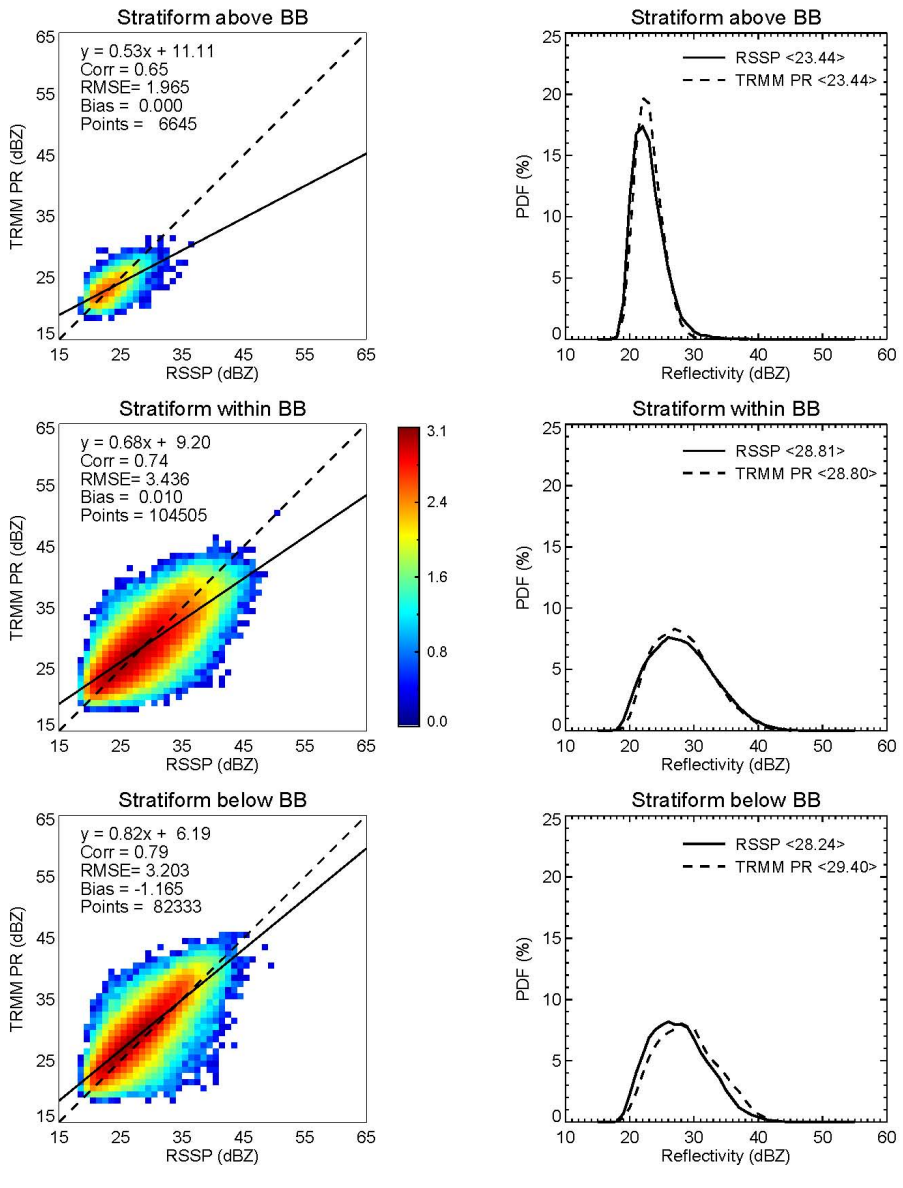
Site ID		Rain Type	Mean Bias
RJNI	Jindo	Stratiform	0.643
		Convective	0.298
RPSN	Pusan	Stratiform	-0.598
		Convective	-0.738
RGSN	Gosan	Stratiform	-2.181
		Convective	-3.070
RSSP	Seongsanpo	Stratiform	-1.906
		Convective	-2.229

Mean Bias Correction

Before mean bias-adjusted♪



After mean bias-adjusted♪



Comparison of Mean RR after Bias Correction

For stratiform rain♪

Site ID	GR rain (old)	GR rain (adj)	PR rain	Gauge rain	GR(adj)-GR(old)	PR-GR(old)	PR - GR(adj)	Gauge - GR(old)	Gauge-GR(adj)
RJNI	3.092	2.817	3.494	3.352	-0.274	0.403	0.677	0.260	0.534
RPSN	2.323	2.532	3.314	3.216	0.210	0.991	0.782	0.893	0.684
RGSN	2.050	2.810	3.680	2.913	0.760	1.630	0.870	0.863	0.103
RSSP	1.961	2.582	3.484	3.073	0.622	1.523	0.901	1.113	0.491

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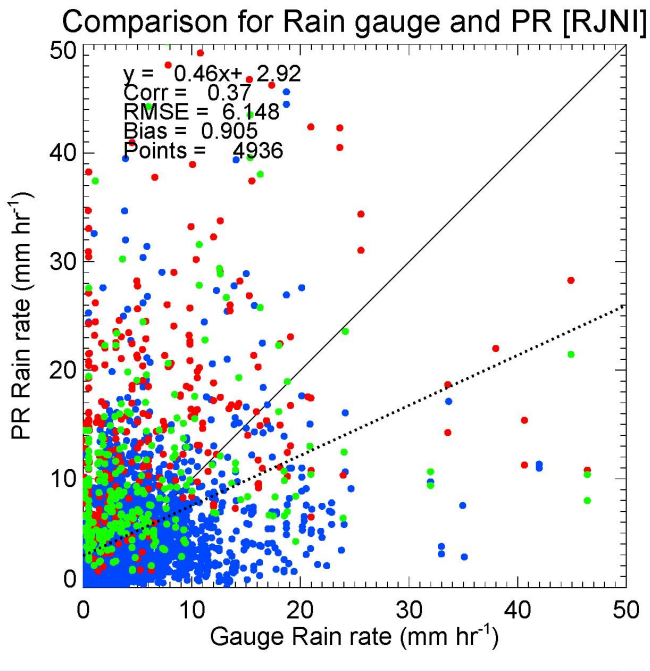
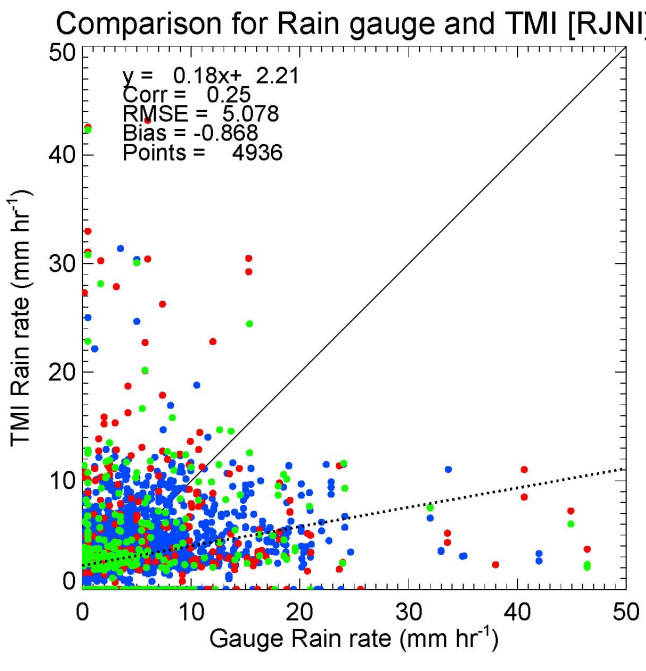
Comparison of Mean RR after Bias Correction

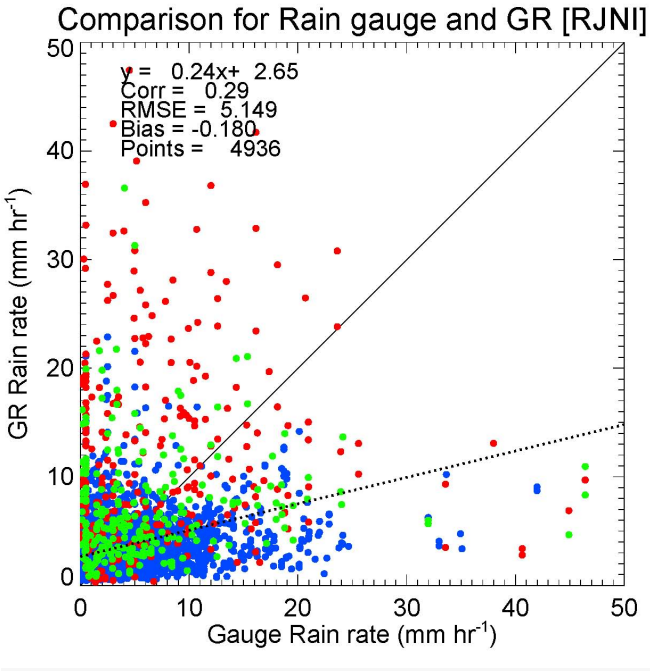
For convective rain♪

Site ID	GR rain (old)	GR rain (adj)	PR rain	Gauge rain	GR(adj)-GR(old)	PR-GR(old)	PR - GR(adj)	Gauge - GR(old)	Gauge-GR(adj)
RJNI	12.827	11.545	16.309	7.389	-1.282	3.482	4.764	-5.438	-4.156
RPSN	9.425	10.391	15.624	8.329	0.967	6.199	5.232	-1.096	-2.062
RGSN	7.944	11.358	18.837	10.326	3.414	10.894	7.479	2.382	-1.032
RSSP	8.493	11.609	18.518	8.900	3.116	10.024	6.909	0.407	-2.709

Comparison of PR-/TMI-/GR-RRs with Gage



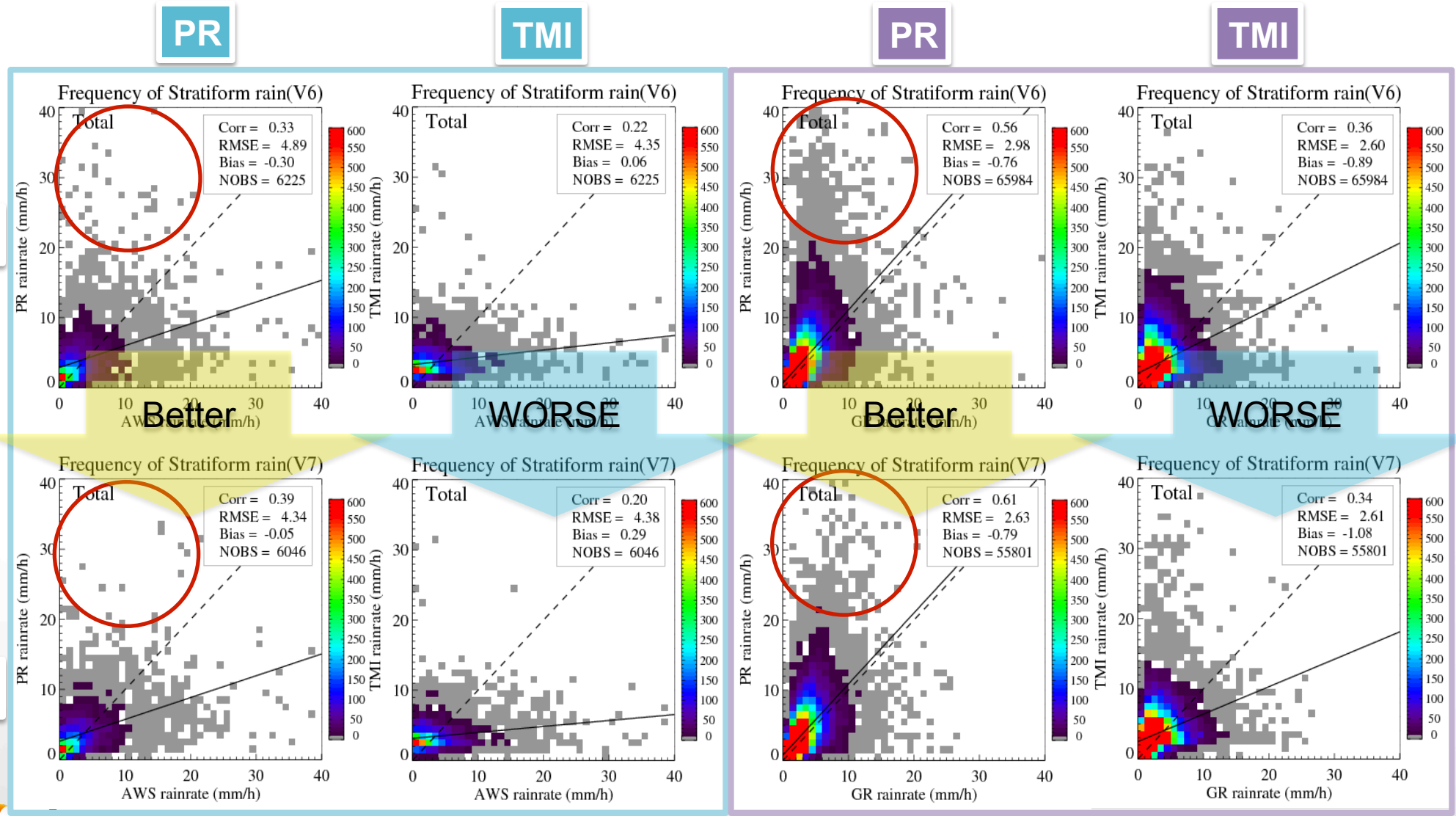




PART II:♪

Evaluation of V7 Algorithm over the Korean Peninsula and Regional Dependency

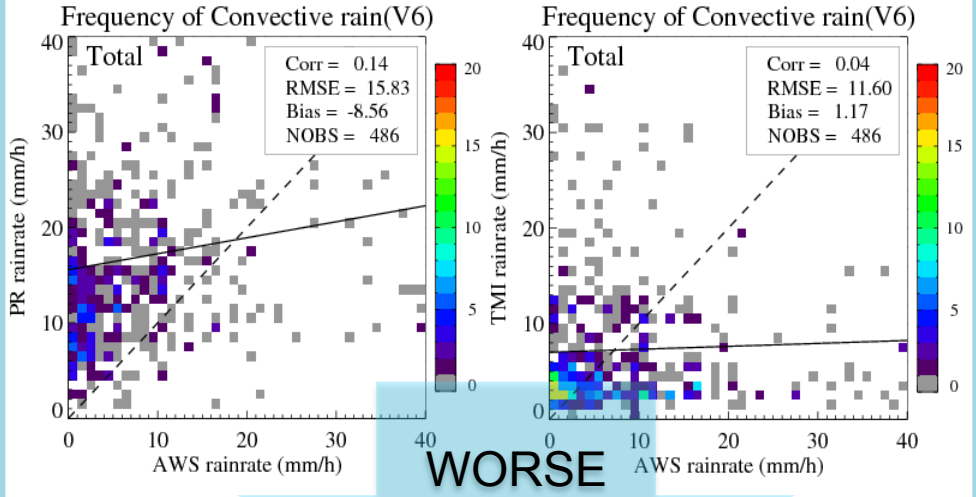
Comparison of Gage & Radar Rainrates(stratiform)



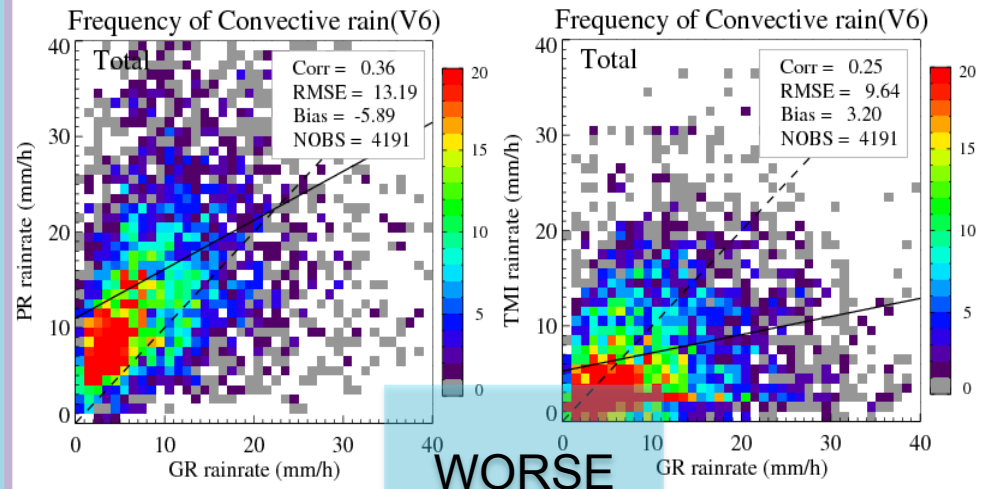
Comparison of Gage & Radar Rainrates(convective)

PR TMI PR TMI

V6

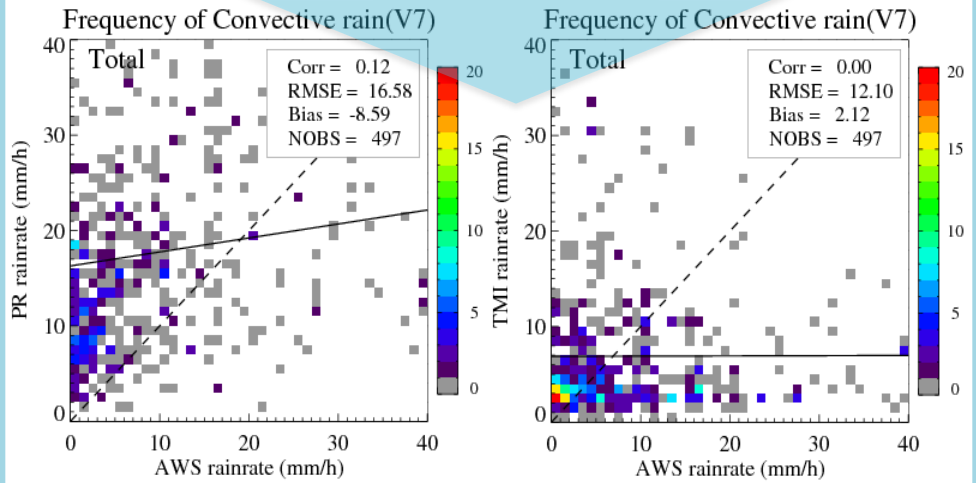


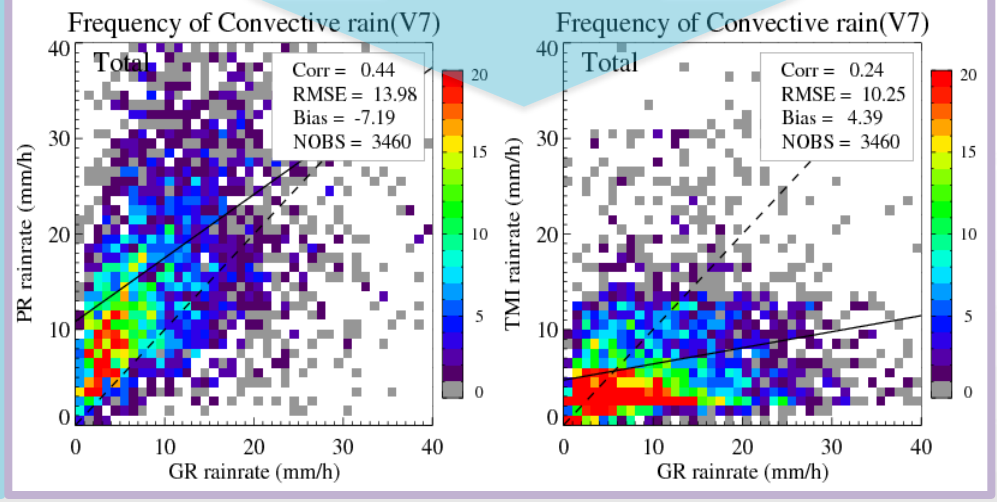
WORSE



WORSE

V7





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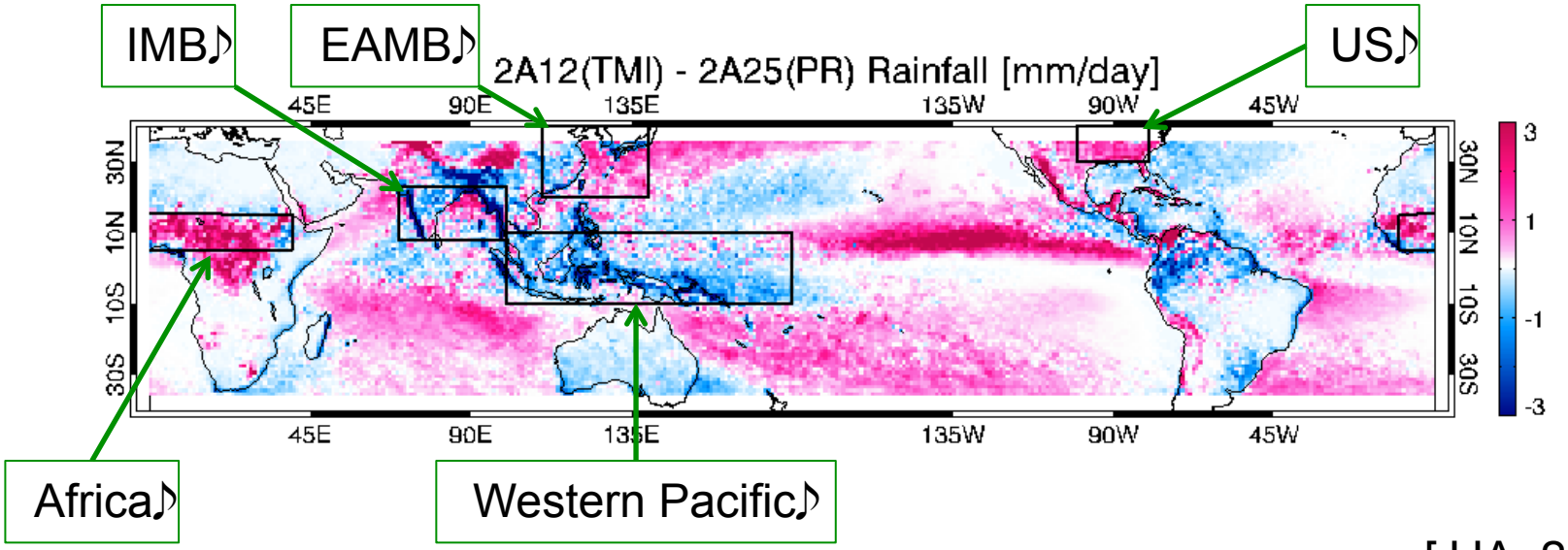
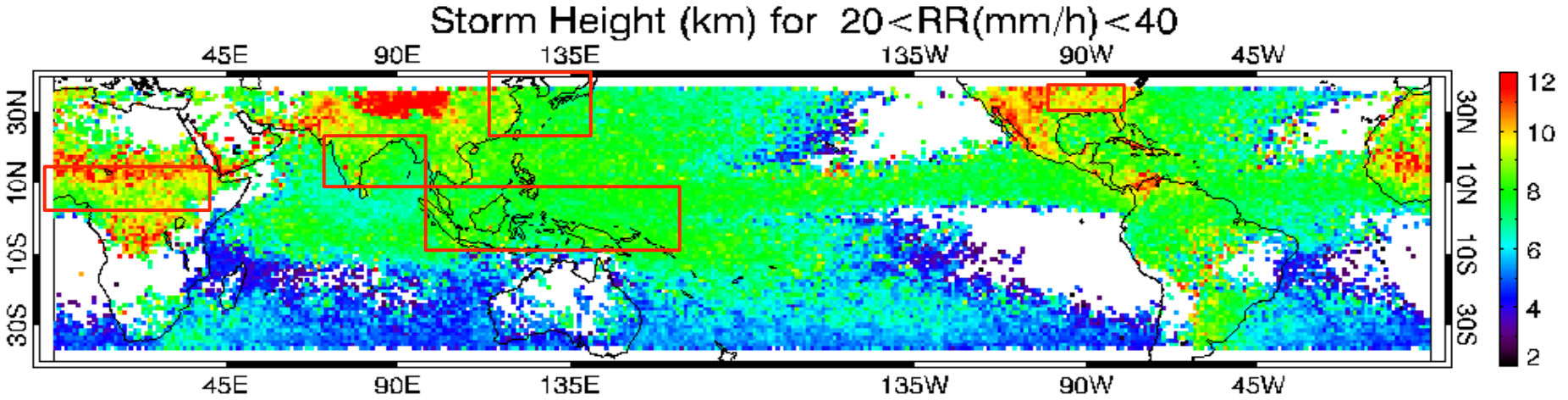
Gages **Radars**

Regional Dependency in Rainfall Retrieval

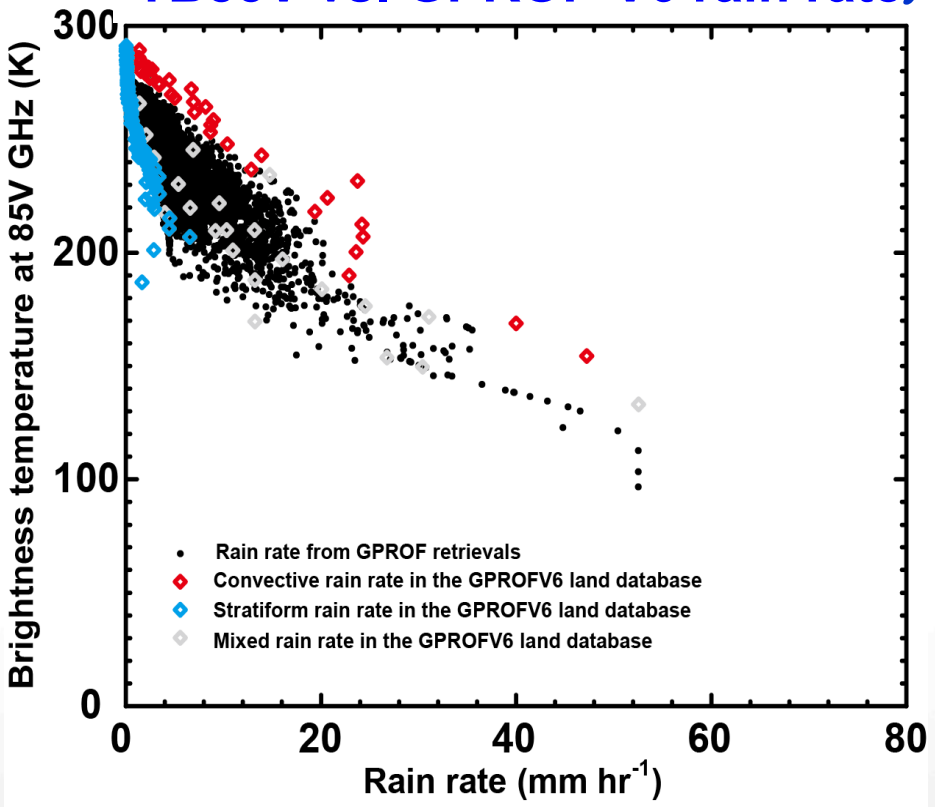


[JJA, 2007-2011]♪

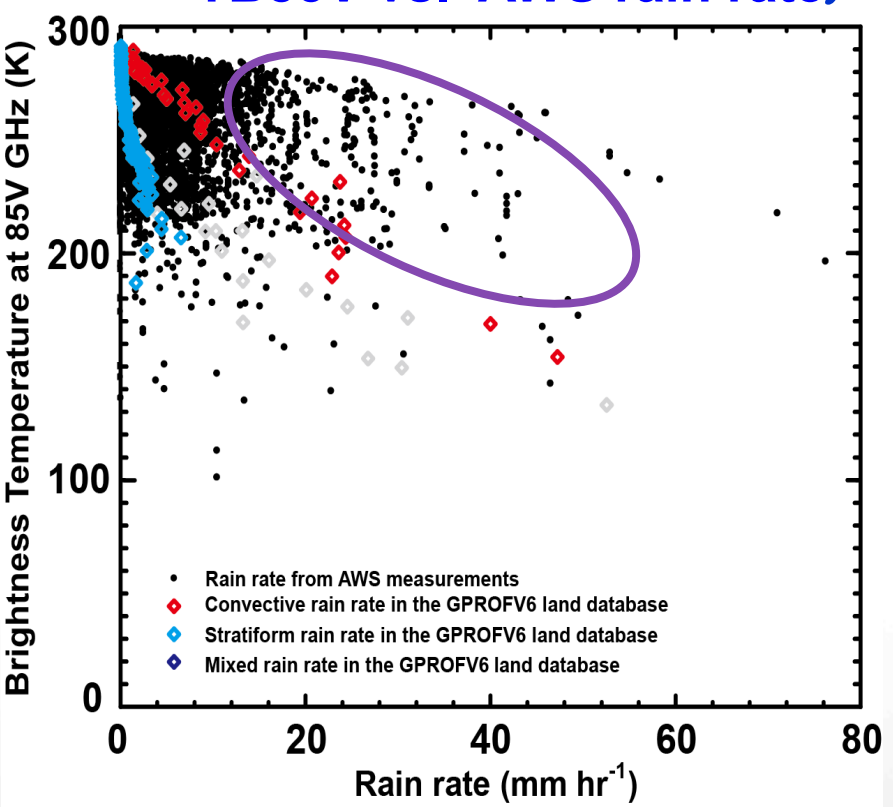


TMI TB85V vs. Gauge Rain Rate (over Korea)

TB85V vs. GPROF-V6 rain rate♪



TB85V vs. AWS rain rate♪



[Ryu et al. 2012, JAMC]

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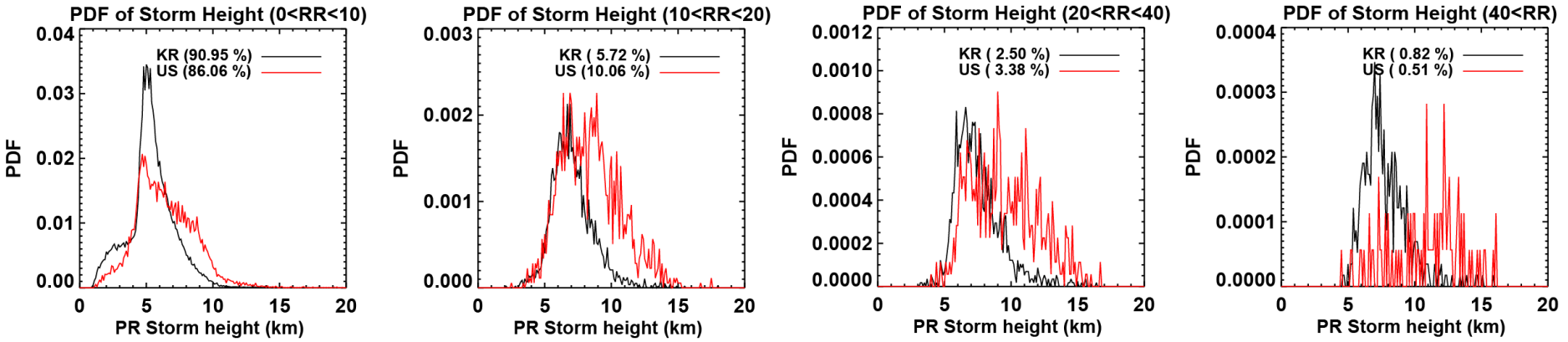
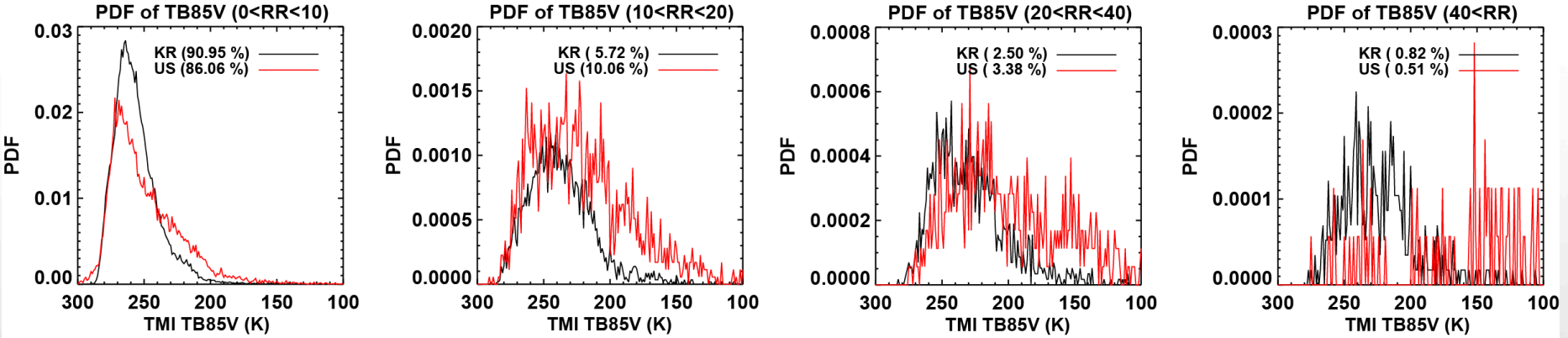
PDF Classified by PR Rain Rate

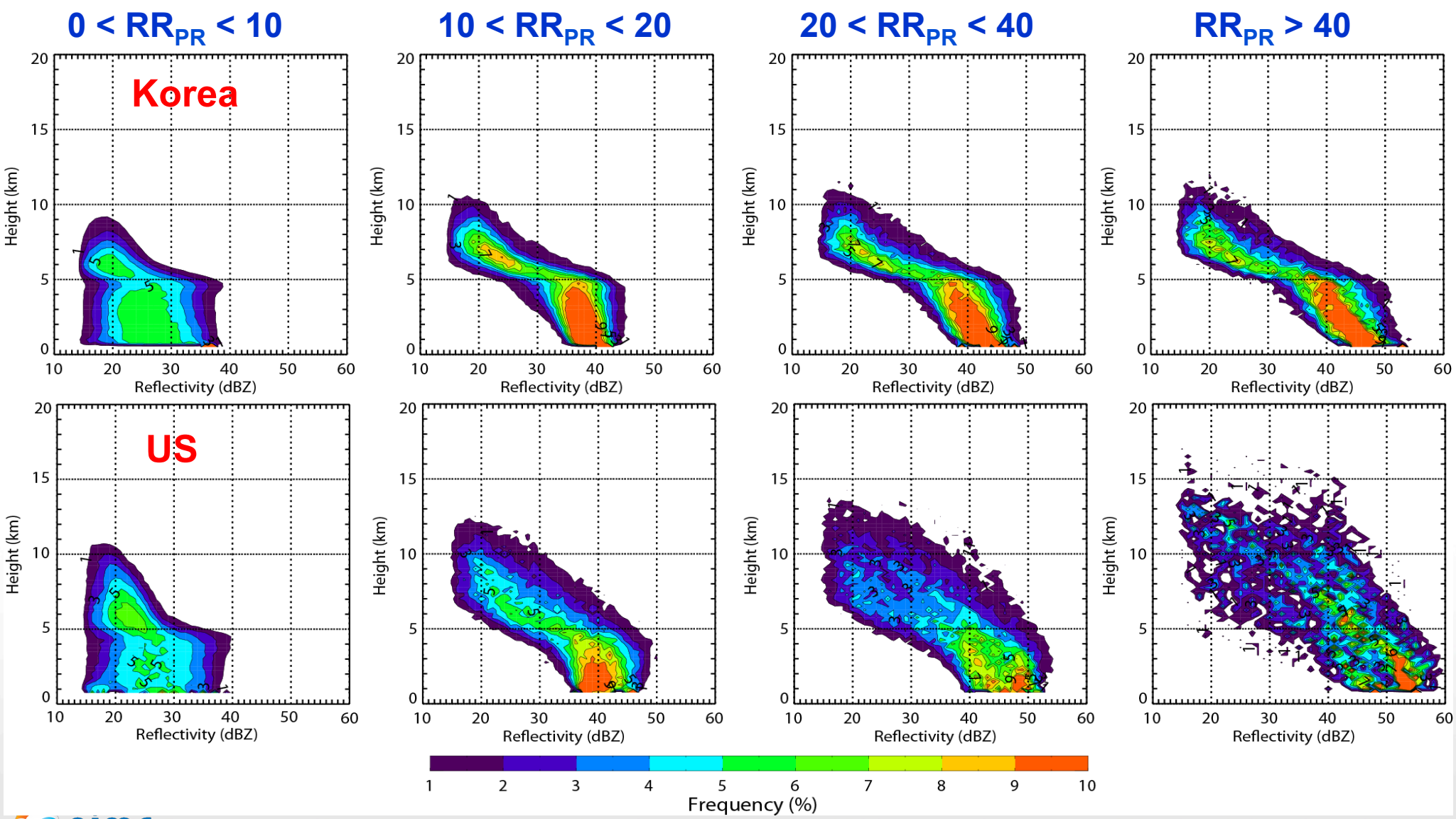
Storm height (TRMM PR)



TB85V (TRMMTMI)



CFADs of PR Reflectivity Classified by Rain Rate

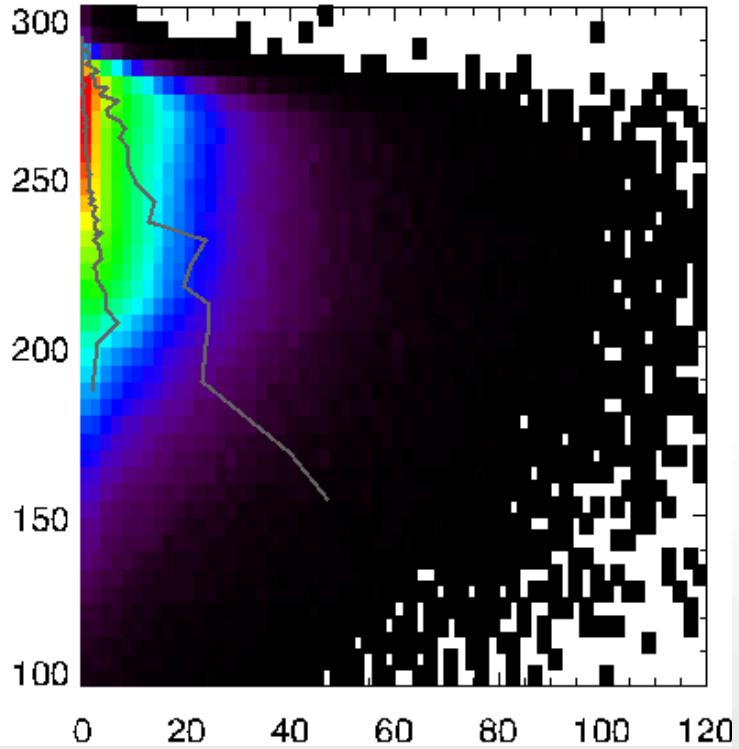


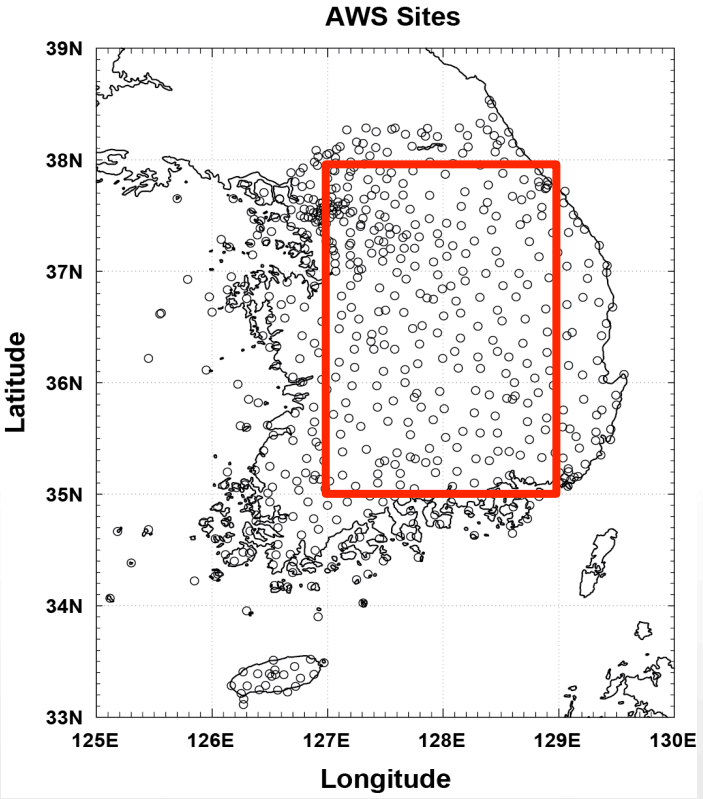
CFADs: Contoured frequency by altitude diagrams

Classification Using K-means Clustering

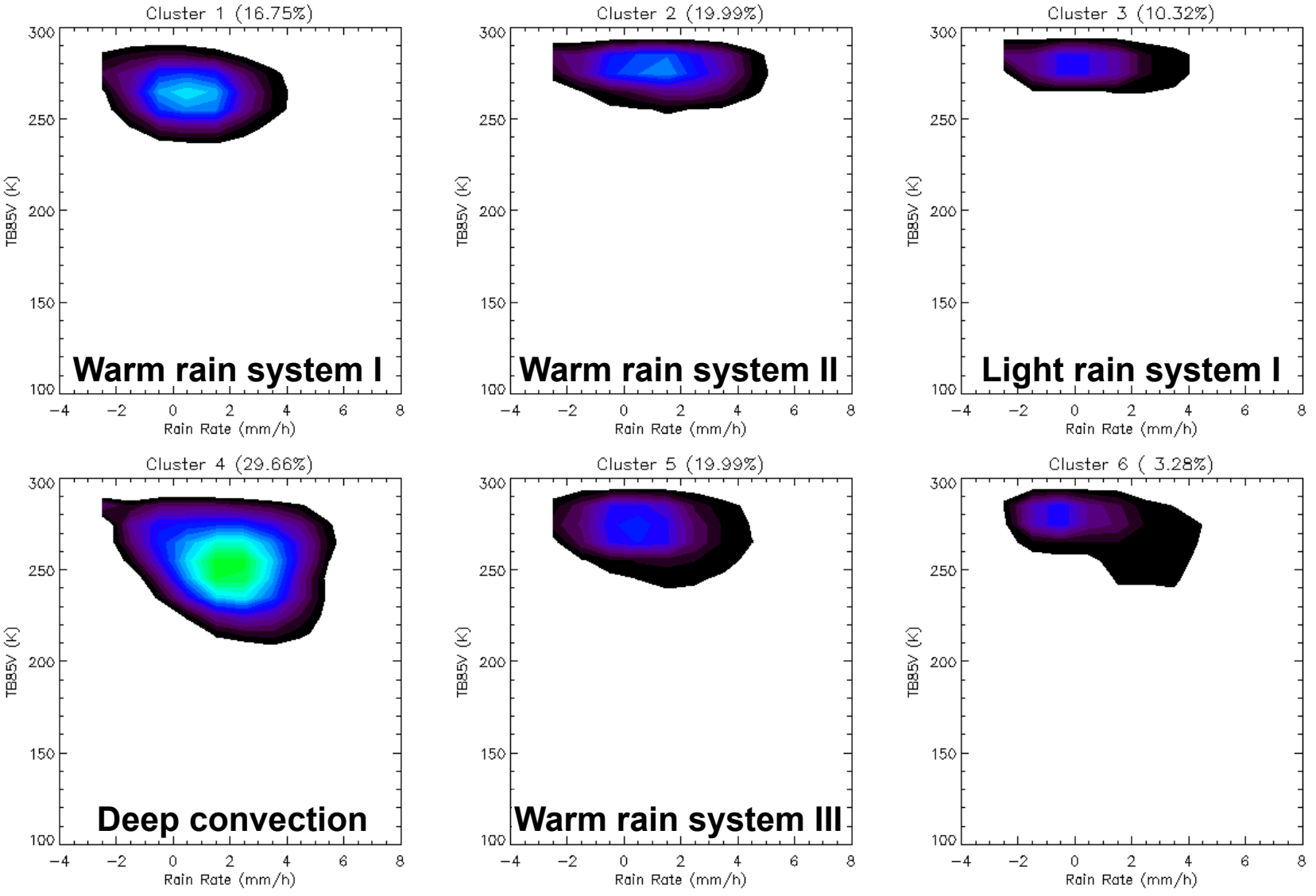
TB85V-RainRate Classification over the Korean peninsula

- Gauge rain rate vs. TRMM TMI TB85V
- Periods: JJA, 2002~2010 (2741)
- Synoptic fields using ERA-Interim reanalysis data





Statistics for Clusters (JJA, 2002~2010)



Results for the Classification

Rain System	Warm Rain I (16.75%)	Warm Rain II (19.99%)	Warm Rain III (19.99%)	Deep Convection (29.66%)
Rain Rate	0 ~ 20 mm/hr	0 ~ 35 mm/hr	0 ~ 20 mm/hr	0 ~ 60 mm/hr
TB85V	240 ~ 280 K	250 ~ 290 K	240 ~ 290 K	210 ~ 290 K
Synoptic Condition	similar to Deep Convection	Strong WPH	relatively weak WPH	
Water Vapor	~ 40 kg/m^2	> 40 kg/m^2	< 40 kg/m^2	~ 40 kg/m^2
Cloud Liquid	High	Low	Medium	High
Cloud Frozen	Medium ~ High	Low ~ Medium	Medium	High

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Summary

- Lower/warm clouds are frequent in rain system which causes heavy rainfall over the Korean peninsula.
    - Warm rain system under various synoptic conditions
- In the deep convection system, there are abundant of water substance including frozen water from the composite field of ERA reanalysis data.
- This study will help to explain the characteristics of rain system over Korea as well as regional aspect of microwave rain retrieval algorithms.
- To reduce statistical distortion, the initial inputs (TB-RR pair) condition will be examined and various clustering methods will be applied.

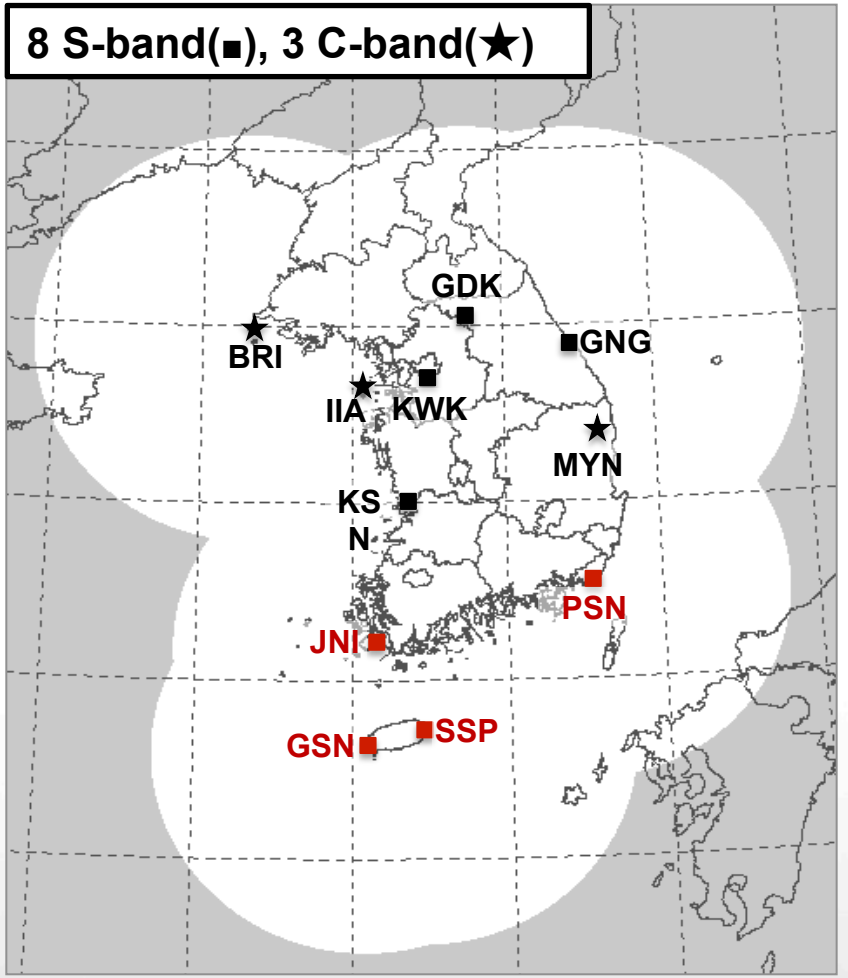
PART III:♪

Plan for Exchange of GPM GV Data over the Korean Peninsula

S-band Radar System at KMA (8 sites)

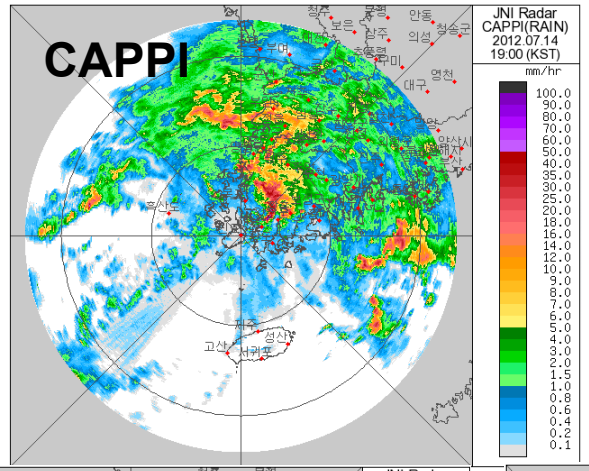
Station code name	Start time	Alt. above sea level of antenna (m)	Obs. radius (km)	Elevation angle (step, °)	
JNI	'01. 10. ~	497	240	11	0.19 ~ 24.3
GDK	'03. 12. ~	1064	250	12	0 ~ 20
KWK	'05. 06. ~	640	240	13	0 ~ 15.8
PSN	'05. 07. ~	547	240	13	0 ~ 15.8
GSN	'06. 06. ~	101	250	15	0.5 ~ 24
SSP	'06. 06. ~	68	250	15	0.5 ~ 24
KSN	'07. 05. ~	231	240	15	0.5 ~ 24
GNG	'10. 04. ~	99	280	16	0.41 ~ 19.95

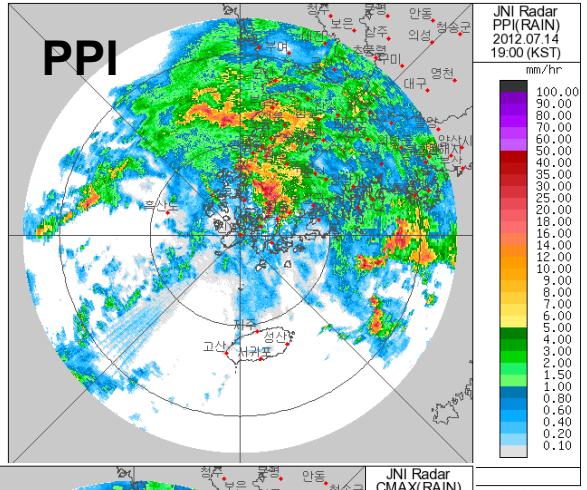
Coverage of KMA Radar

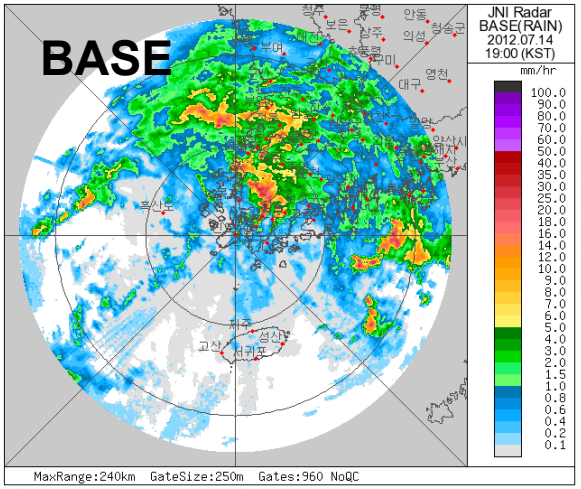


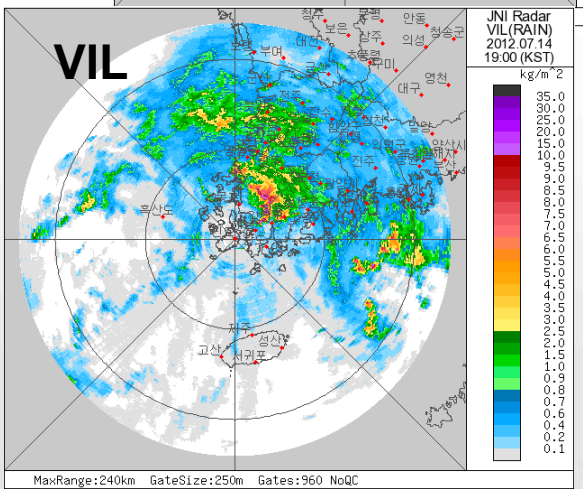
Operational Products

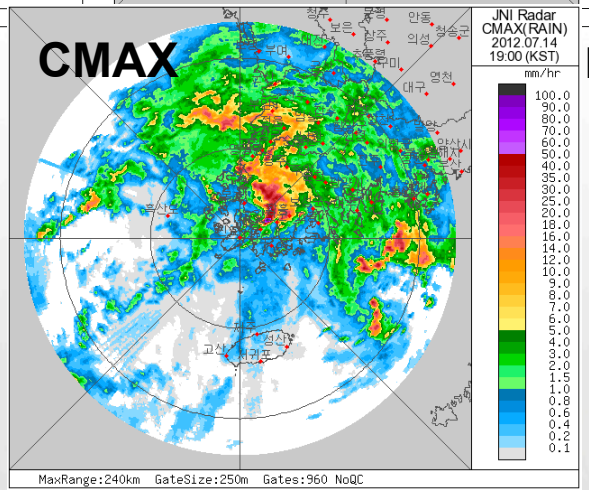
- Radius : 240 km, Resolution : 1km/10minute (for S-band)
- Products : **CAPPI(1.5km, available for higher altitude)**, CMAX, BASE, VIL, ECHO TOP,
  PPI(for all elevation angles at each radar site)
- Dataset : Rain rate, CZ(corrected dBZ), VR(Radial Velocity), SW(Spectral Width)
- QC : No QC data, ORPG QC data
- Archived dataset : No QC/ORPG QC Volume data(UF format)











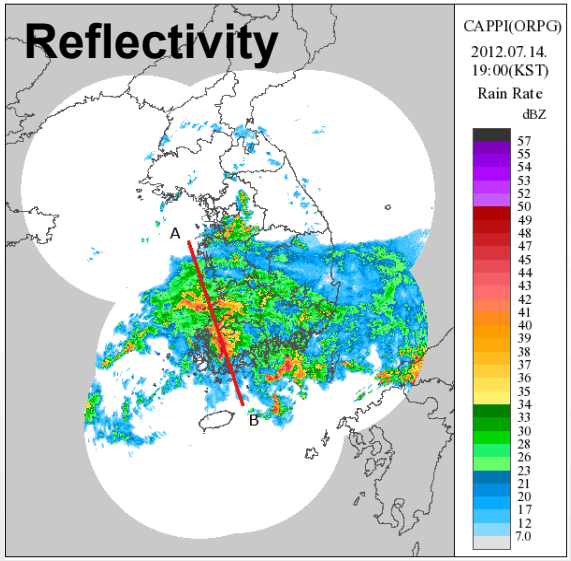
Ex) Products for rainrate at Jindo(No QC)

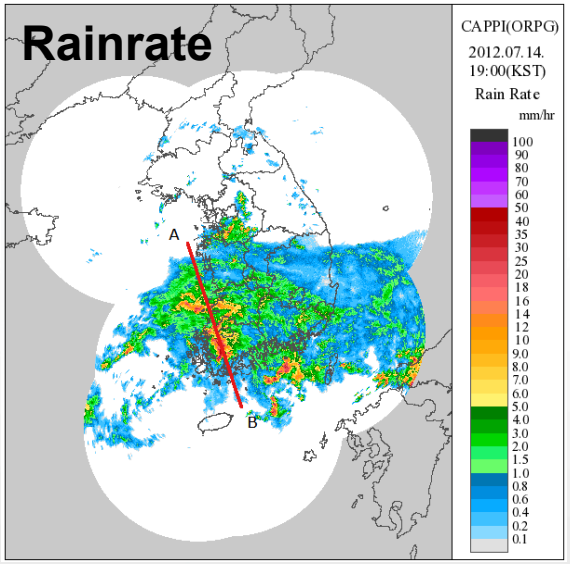
CAPPI : Constant Altitude Plan Position Indicator
PPI : Plan Position Indicator
CMAX : Column Maximum
BASE : Lowest layer echo in vertical column data
VIL : Vertically Integrated Liquid
ETOP : Echo Top

Operational Products (Composite)

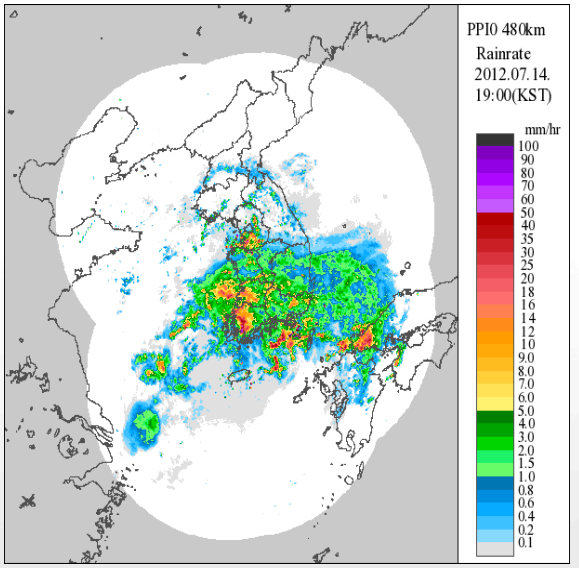
- Reflectivity is converted to rainrate by Z-R relationship(M-P equation).
- Composite image of reflectivity and rainrate
  - Resolution : 1km/10minute / Radius : 240 km, 480 km
  - Products : **CAPPI(1.5km), PPI(0°)**, CMAX, BASE, VIL, ECHO TOP
  - Dataset : Reflectivity, Rainrate
  - QC : No QC data, ORPG QC data
  - Values over the region of overlap : maximum reflectivity or maximum rainrate

240 km Composite Image





480 km Composite Image



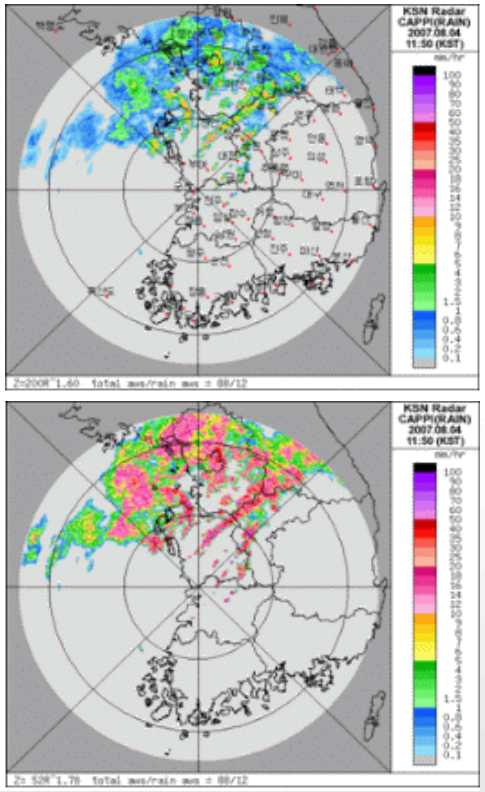
Radar-AWS Rainrates (RAR System)

- Used datasets : CAPPI per 10 minute at 1.5 km(ORPG QC data)
  AWS rainrate per 1 minute converted by TRMM-GSP algorithm
- Resolutions of RAR : 1 km/10 minute or hourly
- QC : Mean field bias correction(smoothing effect)
- RAR system has operationally produced rain rates(composite or each site) since 2012

.

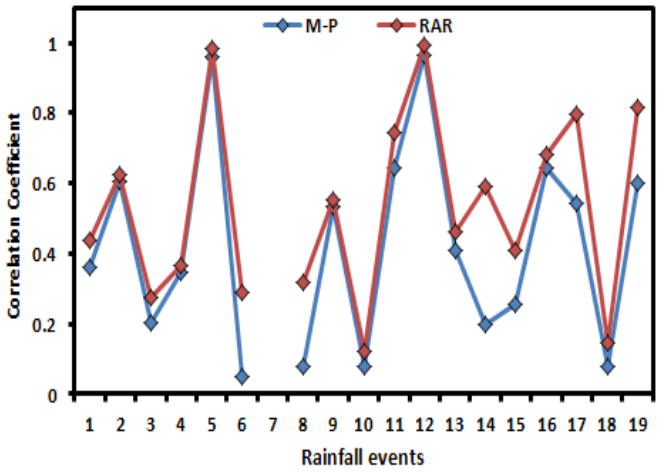
M-P

RAR

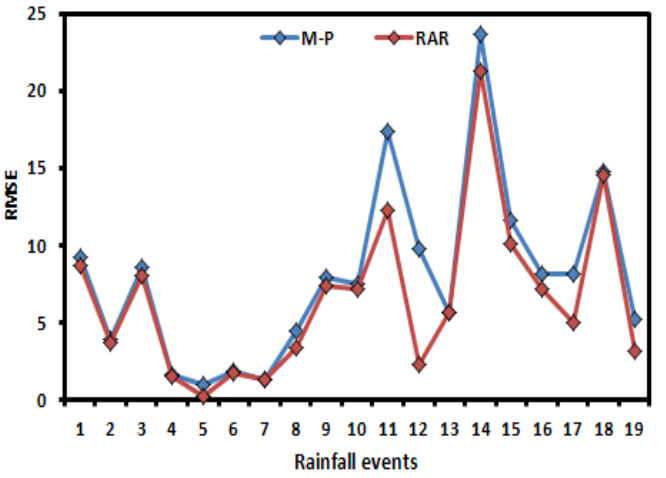


KSN Site (4 Aug. 2007)

Correlation coefficient



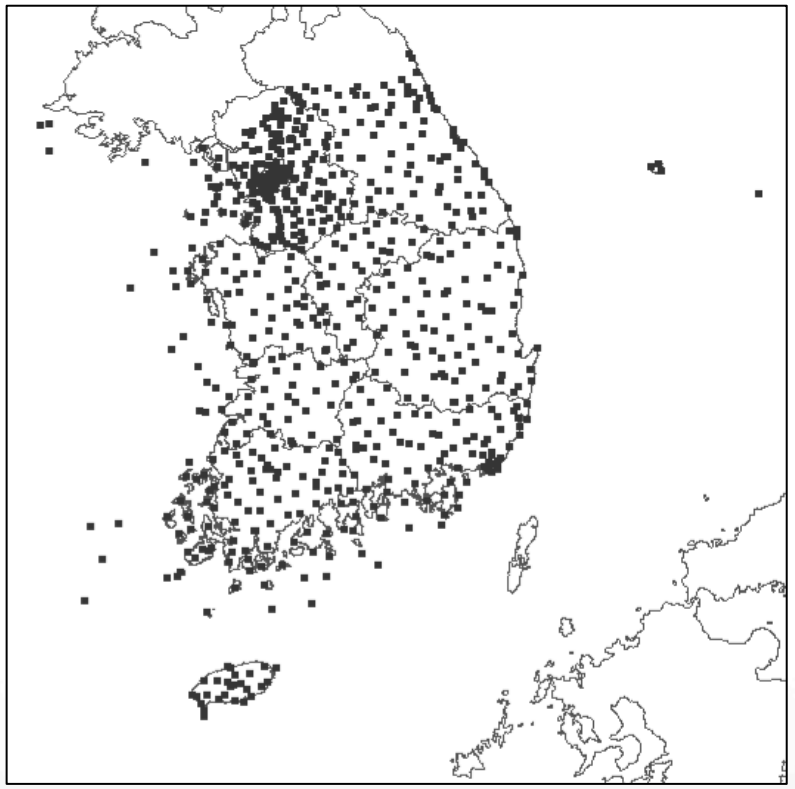
RMSE



※ Referenced by Final report of Weather Radar Center at KMA (2011)
※ Case study : 1 July 2007, 4 Aug. 2007

AWS Observations

AWS stations over the Korean Peninsula

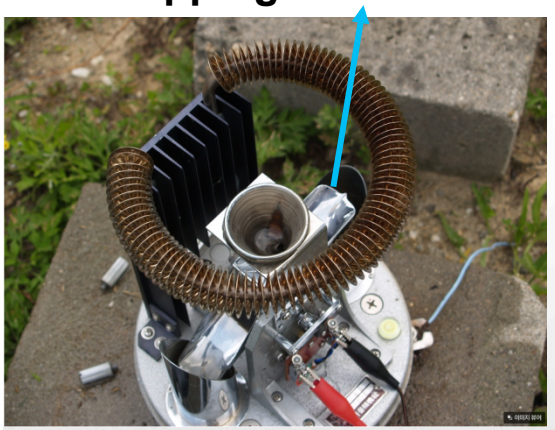


- Current status
  - Start time : 1988(15 stations)~
  - Mean distance between equipments : 13 km
  - Number of AWS stations : 686(‘13. 03)
  - Frequency : 0.5 mm tipping-bucket / 1 minute
  - QC : produce error flag files(remove abnormal data)

- QC algorithm will be systemized in 2013.

Rain Gauge

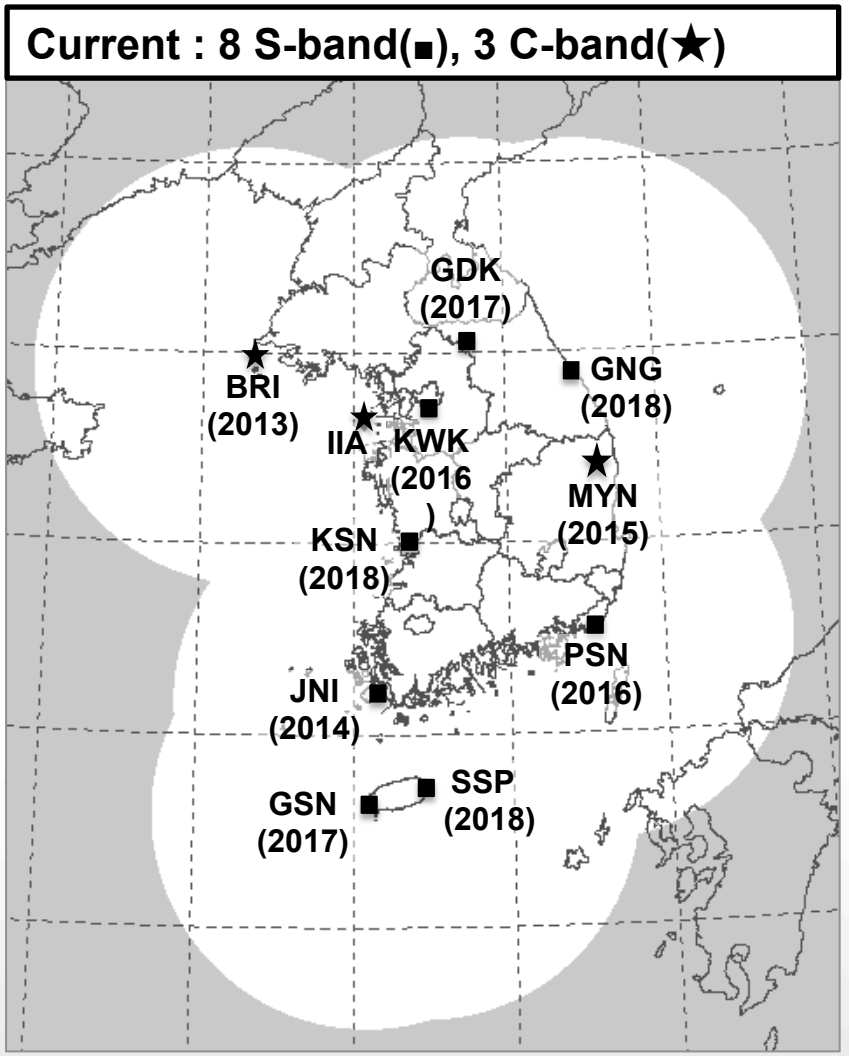
Tipping Bucket



Replacement to S-band Dual Polarization Rad

Year	2013	2014	2015	2016	2017	2018
Site	BRI	JNI	MYN	KWK PSN	GDK GSN	KSN SSP GNG

KMA will replace the radar systems to **S-band d ual polarization radars** from 2013.



Summary on GV Data Exchange

- GV Data Sets
  - Hourly 1-km gauge adjusted precipitation data over the Korean peninsula
    - KMA RAR system rain rates
  - KMA S-band radar reflectivity factor data
    - selected set of KMA S-band radars
  - KMA rain gauge data if necessary

- As a trial basis, the KMA ftp server can be used right a way, and then routine data exchange will be implemented.

- NASA-generated data will be compared with the Korean GV data with TRMM/PR and GPM/DPR data.

♪

THANK YOU

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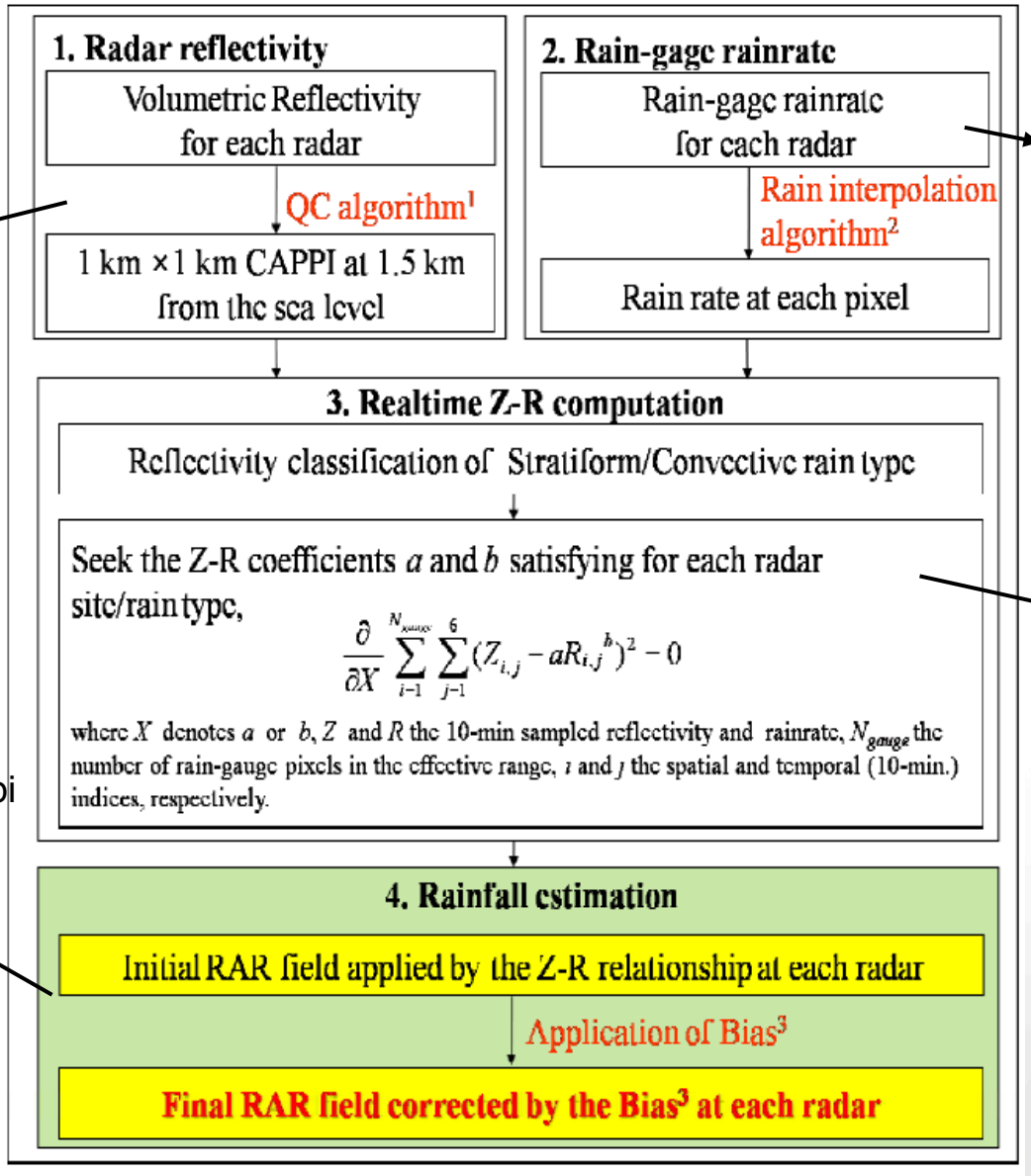
Backup Slides♪

Algorithm of RAR System

ORPG QC
(remove non meteor ological echo, Zhang, 2004)

CAPPI at 1.5 km altit ude by Mohr's interp olation method(Mohr, 1979)

QPE (Quantitaitve Precipi tation Estimation) for the each radar site



AWS rainfall QC
(Kondragunta and Shrestha, 2006 and Zahumensky, 2004)

1. Missing value test
2. Physical limit test
3. Climate range test
4. Internal conformity test
5. Spatial continuity test

WPMM algorithm
(Window Probability Matching Met hod, Rosenfeld et al., 1993)

The effective area of AWS rainrate < threshold at each radar site → Marshall-Palmer equation