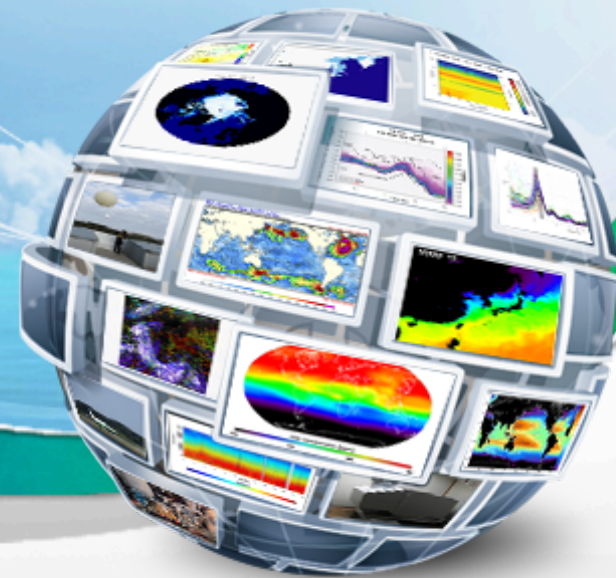


2011 NASA PMM Science Team Meeting
November 7-10, 2011
Denver, CO, USA

KMA Activity on GPM GV: Statistical Comparisons and Future Plan

Mi-Lim Ou
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Contributors : Mee-Ja Kim, Ji-Hye Kim (Remote Sensing Research Team)

Outline

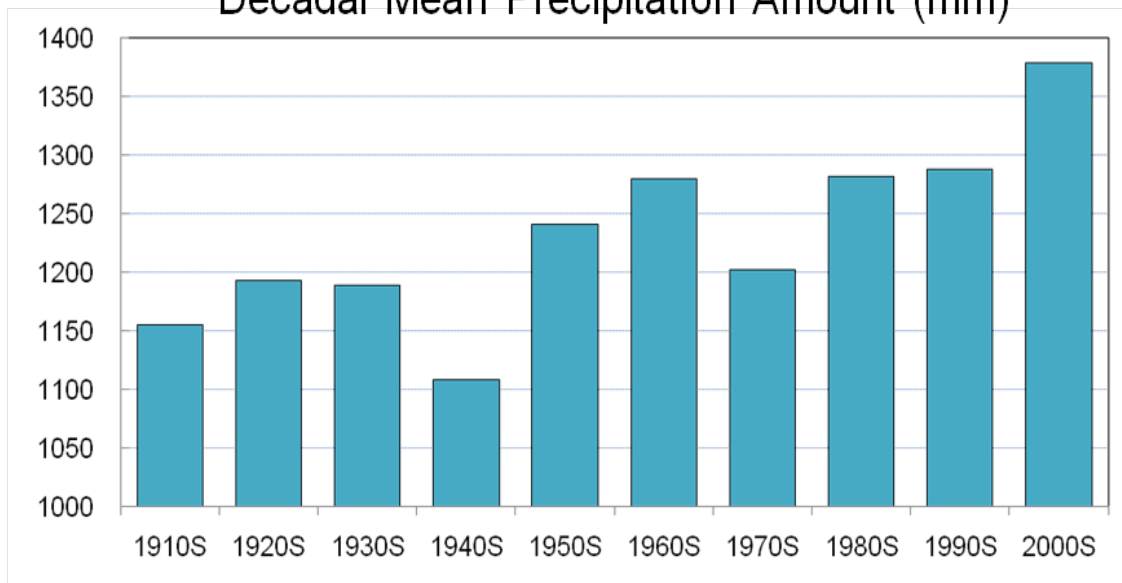
1. Background
2. Objectives
3. Ground Validation : Statistical Comparisons
4. Plan for Replacement of the KMA Radar System
5. Investigating Characteristics of Rain
6. Summary

Background

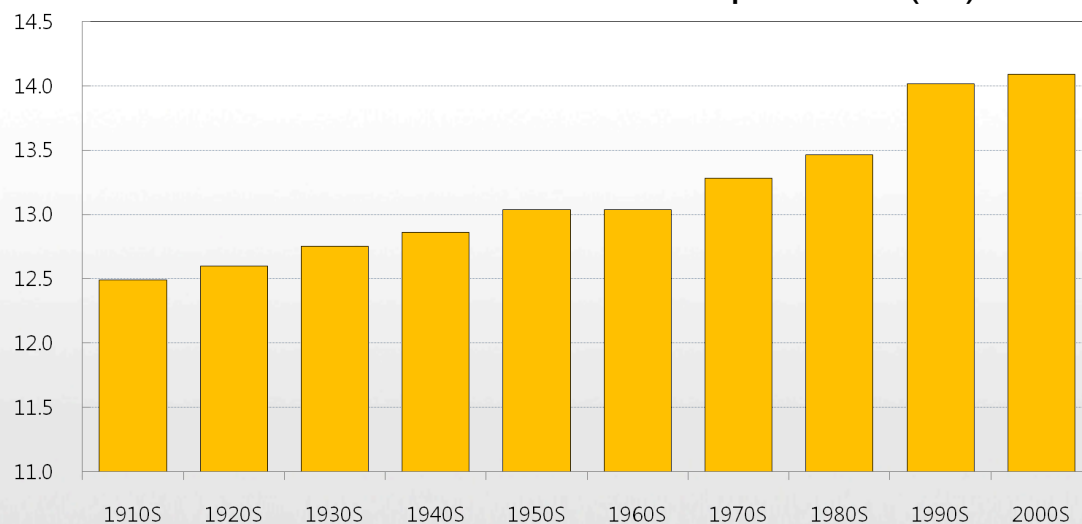
- Main Weather Phenomena over Korea
 - June-July : Rainy season due to Chang-Ma front
 - End of August – September : Typhoon season
 - December – February : Cold and snow season
- However, it has been changing.
 - Heavy rain events due to locally developed thunderstorms increase rather than typical synoptic-scale rain such as Chang-Ma.
 - Typhoons hit Korea in late Spring or early Summer.
- It is necessary to monitor and understand those changes globally with improved data of higher resolution in time and space through satellite observations.

Climatology for 6 Main Cities in Korea

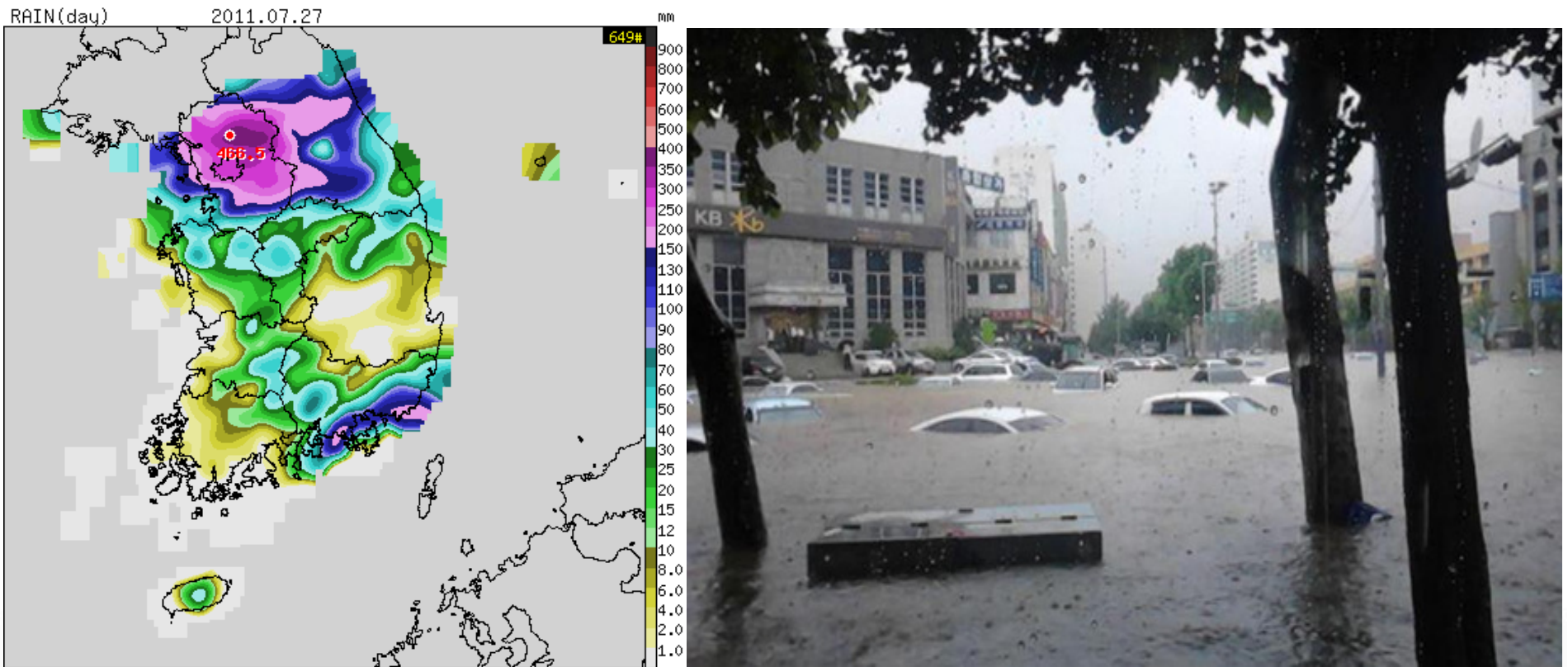
Decadal Mean Precipitation Amount (mm)



Decadal Mean Temperature (°C)



Flash Flooding in Seoul, Korea (July, 2011)



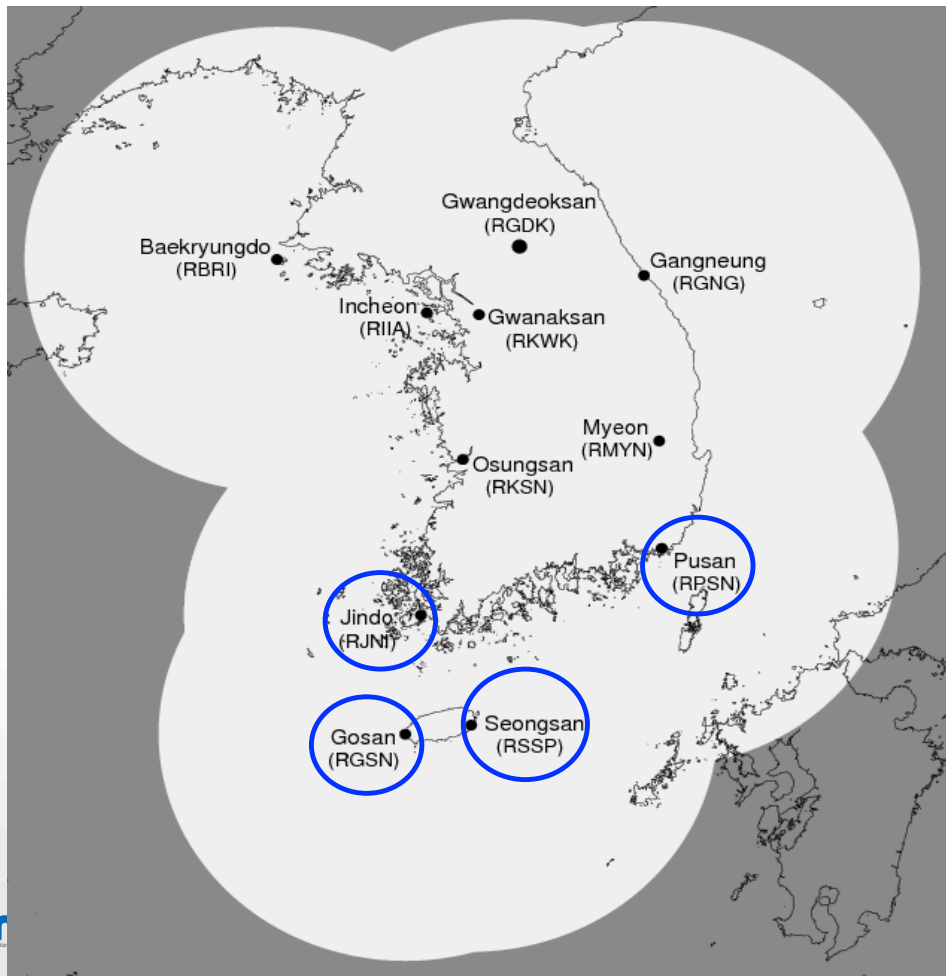
July 26-28, 2011 : 587.5 mm in Seoul for 3 days

Objectives

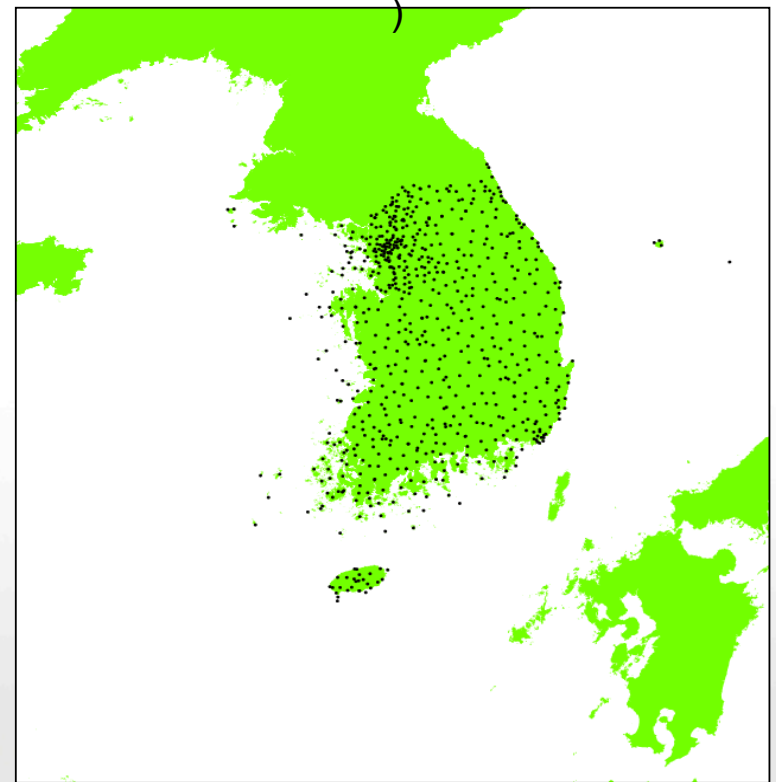
- ❖ KMA retains dense surface observation network including surface rain gages, ground-based radars, and intensive observation sites.
 - It gives an excellent environment for GPM ground validation(GV) over Korean peninsula.
 - “NASA GPM/PMM Joint Research on GPM GV over Korea has started in 2009.
- ❖ The purpose of this study is **to develop a prototype S/W of ground validation for GPM** over the Korean peninsula.
 - **Performing statistical comparisons** between gauges, S-band radars and TRMM/PR & TMI
 - **Investigating vertical structures of rain events** using surface observations such as MRRs, Parsivel, vertical pointing radar(Vertex)

In-situ Observation Sites in KMA

KMA Radar Network
(11 Radars in operation (8 S-band radars))



KMA Rain Gage Network
(541 in operation, 13 km spacing)



GPM Ground Validation

Statistical Comparisons

- Prototype for Korea Peninsula
- Completion of 4-year data processing

TRMM Data, Ver.6

❖ Precipitation Radar(PR)

- Active Microwave Sensor
- Frequency : 13.8 GHz
- Horizontal resolution : 4 km
- Vertical resolution : 250 m

❖ 1C-21

- Raw calibrated reflectivity (dBZ)
- Product : Land/Ocean Flag

❖ 2A-25

- Attenuation-corrected reflectivity (dBZ)
- Products : Rain type, Bright-Band Height (BBH

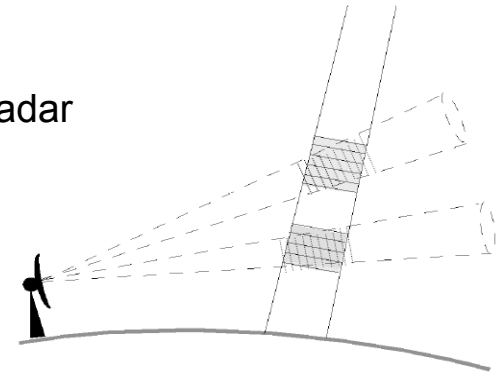
Ground-based Radar (GR)

❖ KMA S-band Radars (4 sites)

- Frequency : 2.7 ~ 2.9 GHz
- Horizontal resolution : ~ 1 km
(observation radius : 240~250 km)
- Vertical resolution : 1.5 km
- Quality-controlled CAPPI reflectivity
- Time freq. : every 10 minute
- Product: Rain type

Geometry-Matchup Criteria

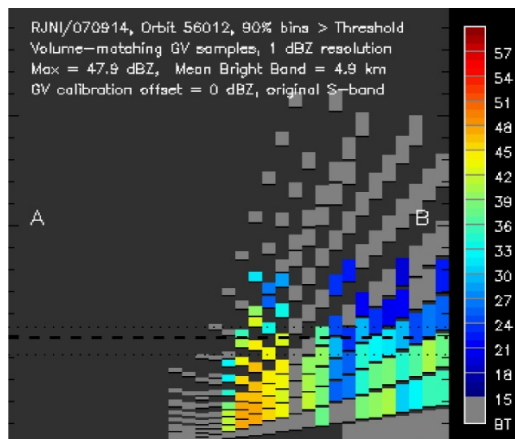
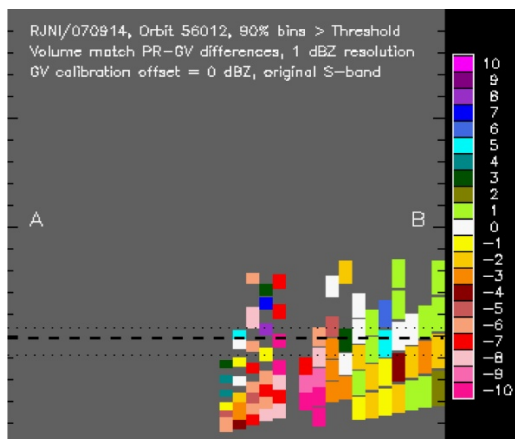
- ❖ Period : August 2006 – August 2010
- ❖ Spatial re-sampling
 - 4 km resolution in horizontal within 100km radius of a ground-based radar
 - 1.5 km resolution in vertical from 1.5 to 19.5 km
- ❖ Temporal matching
 - Obtain ground based radar data within ± 5 minutes interval for TRMM overpasses
- ❖ Rain events : on the criteria over 100 rain pixels in the overlapped area
- ❖ PR reflectivity of 18 dBZ or greater and ground-based radar reflectivity of 15 dBZ are used to compare mean reflectivity.
 - The cutoff thresholds are applied. (PCT=90)
- ❖ Number of selected cases



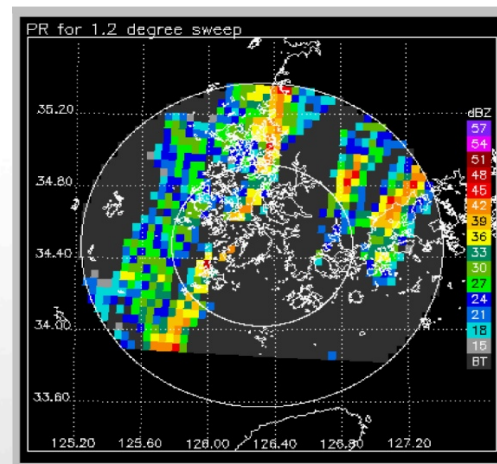
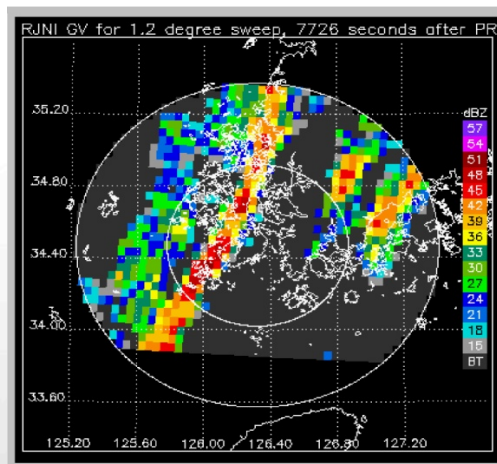
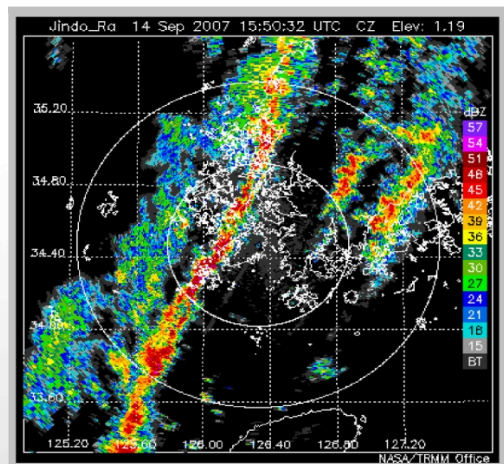
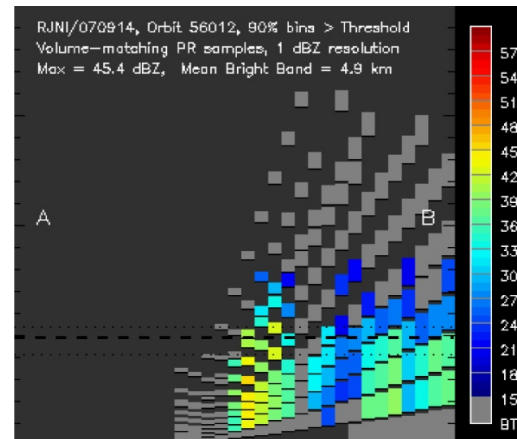
RPSN	RJNI	RGSN	RSSP
201	297	208	211

Validation Network S/W by NASA

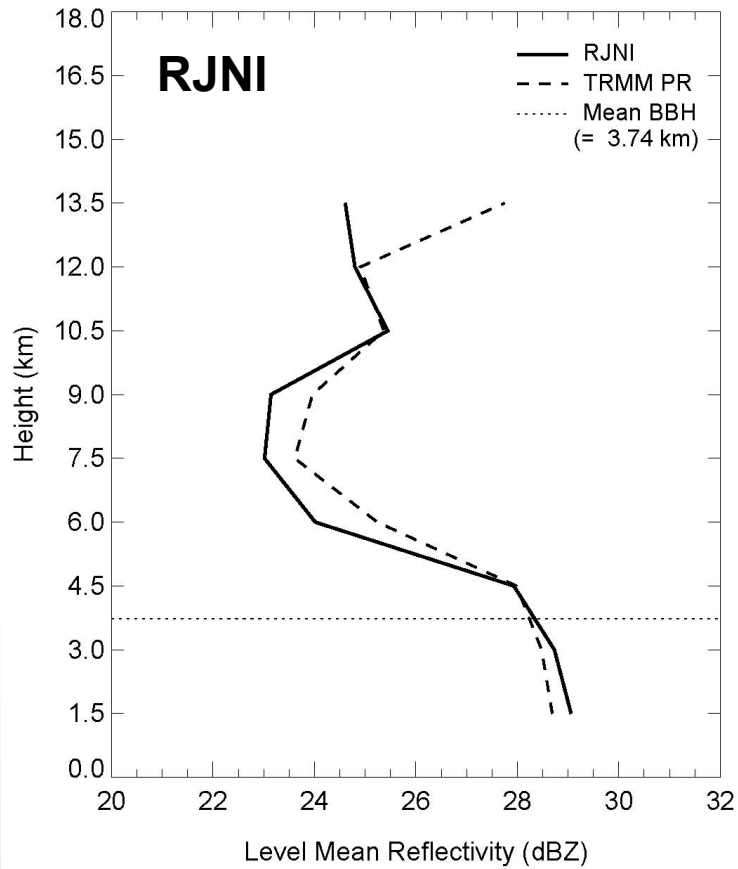
GV



TRMM/PR

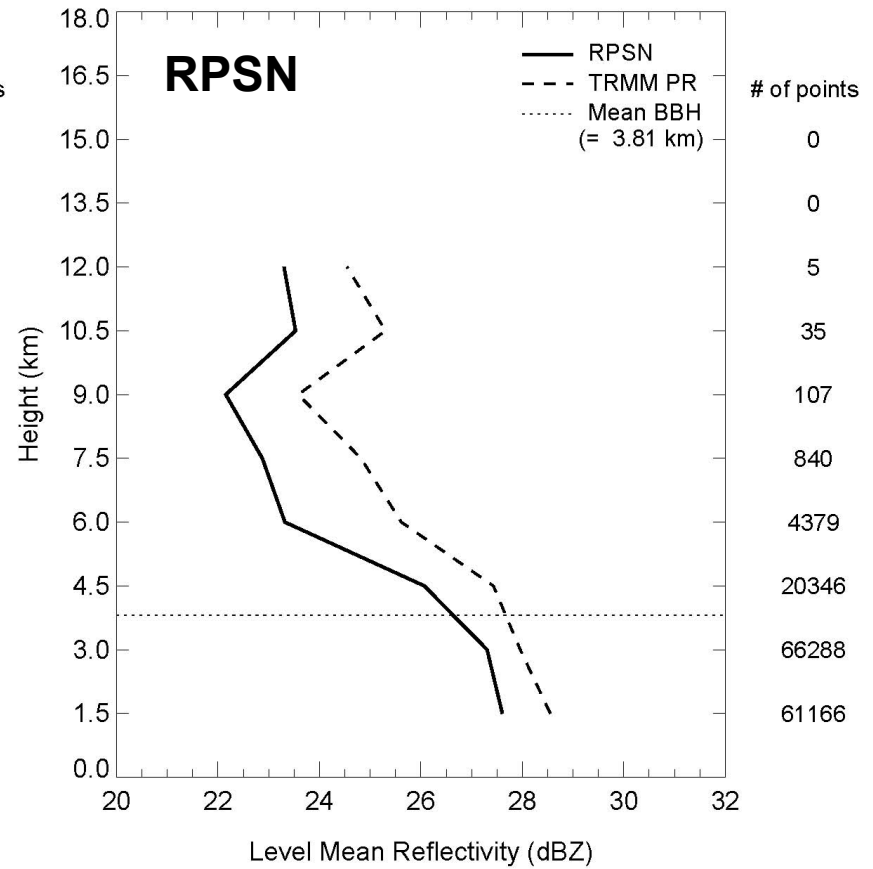


Layered Averaged Reflectivity



of points

0
 1
 17
 75
 493
 3136
 14285
 46627
 80286
 61773

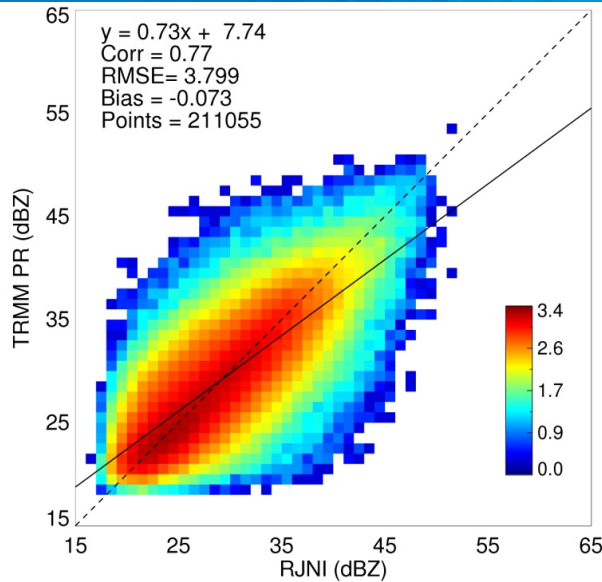


of points

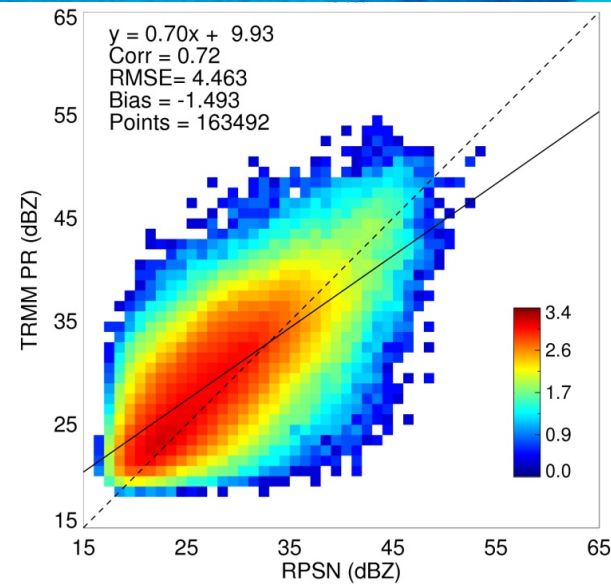
0
 0
 5
 35
 107
 840
 4379
 20346
 66288
 61166

Scatter Plots for Reflectivity (Total Cases)

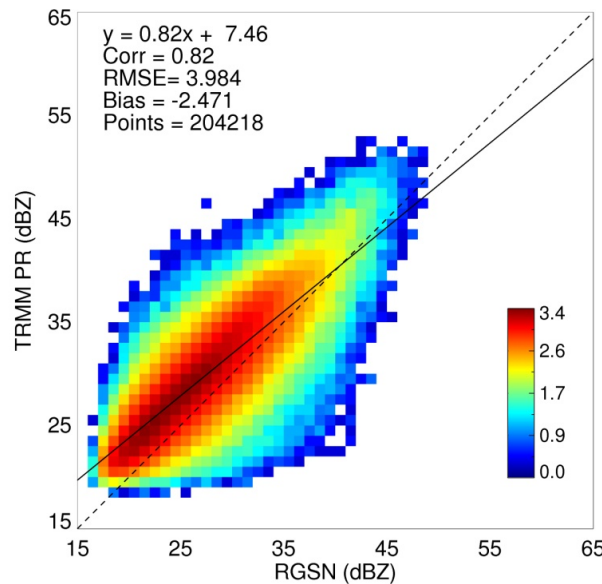
RJNI



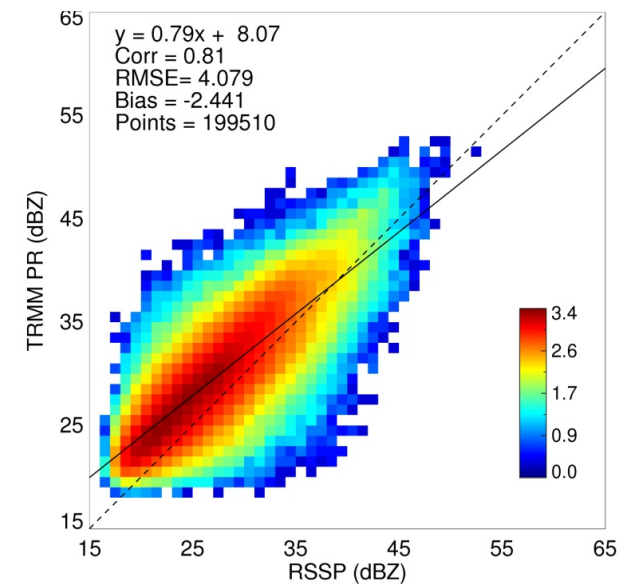
RPSN

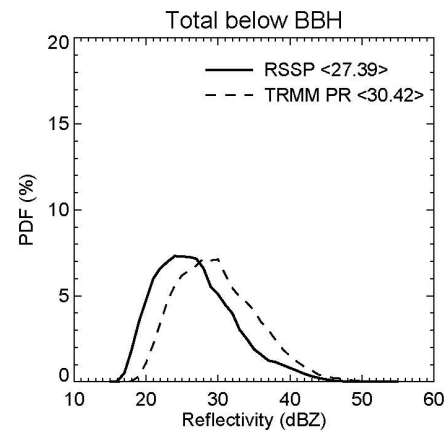
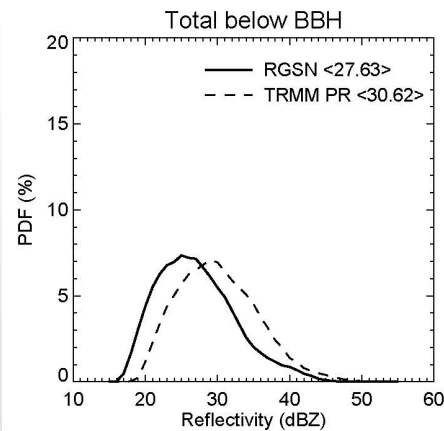
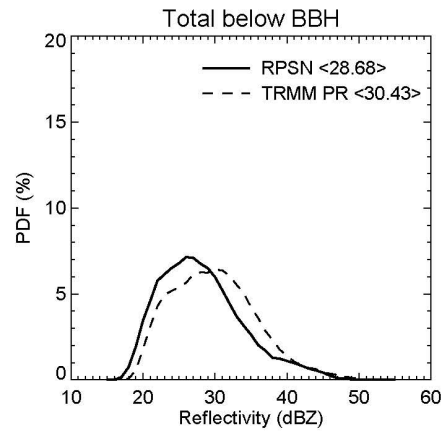
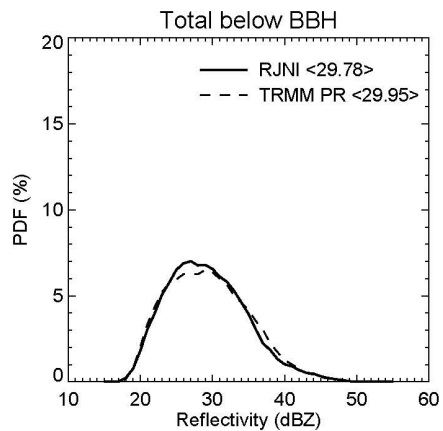
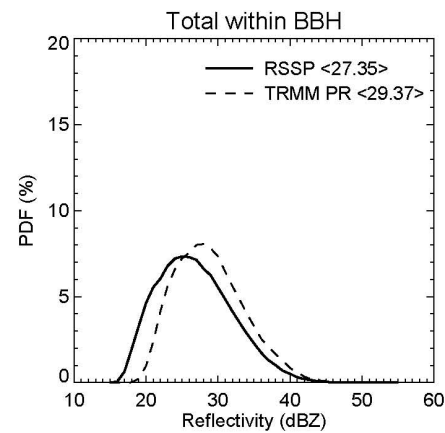
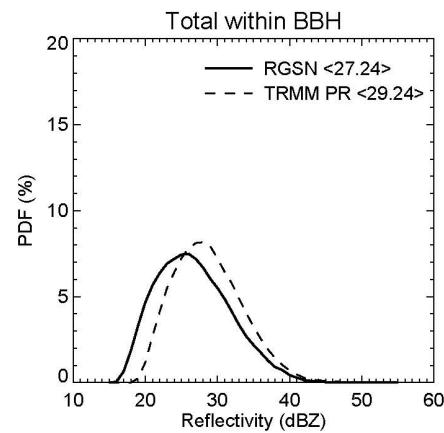
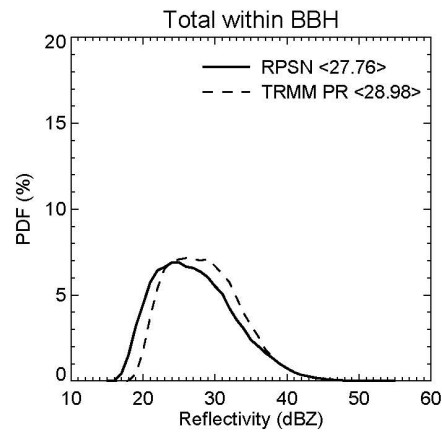
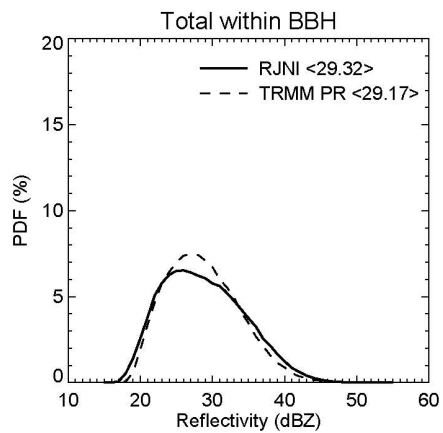
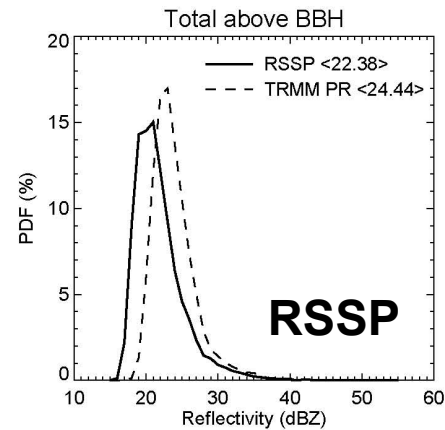
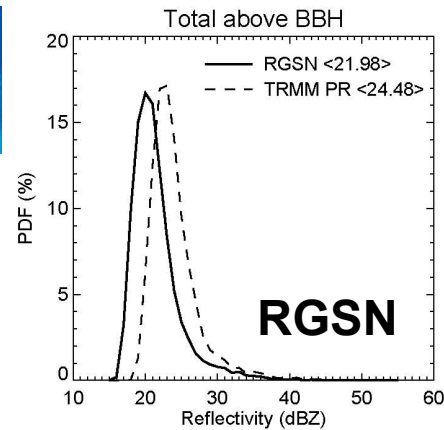
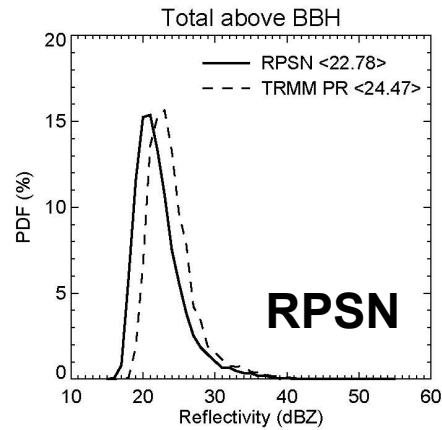
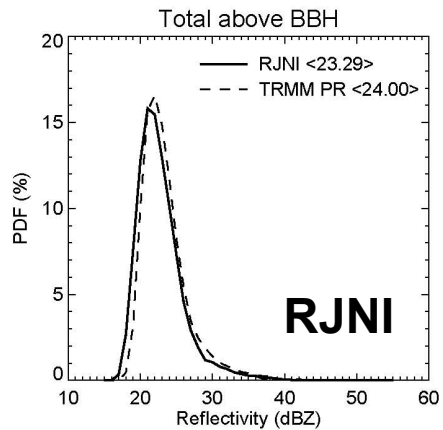


RGSN



RSSP

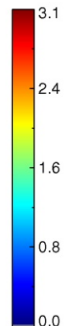
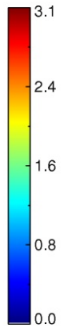
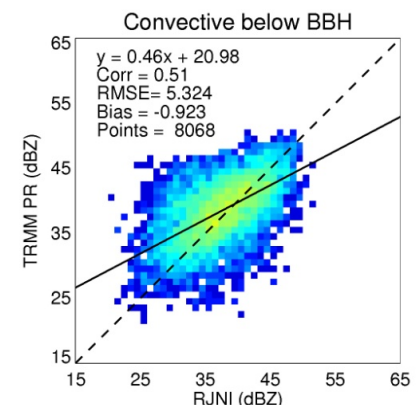
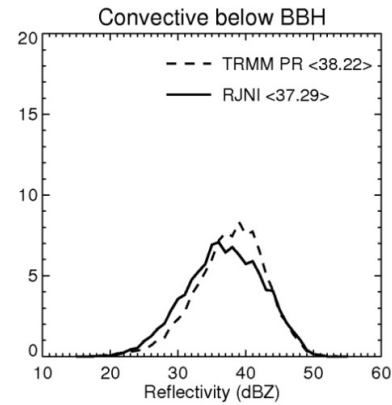
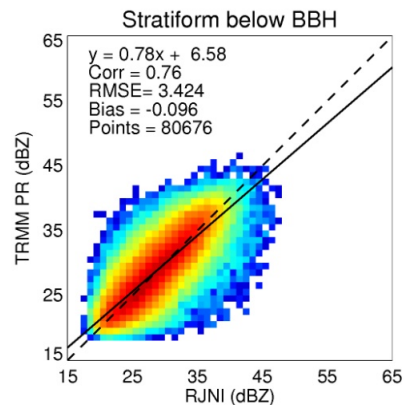
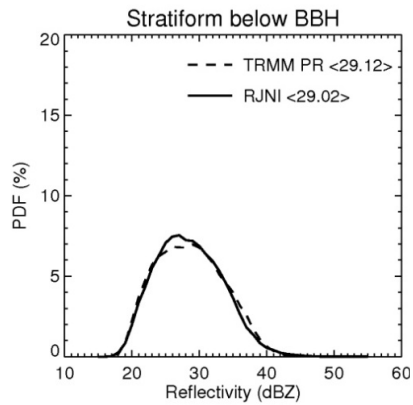
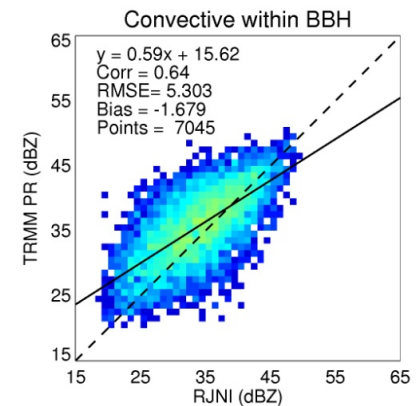
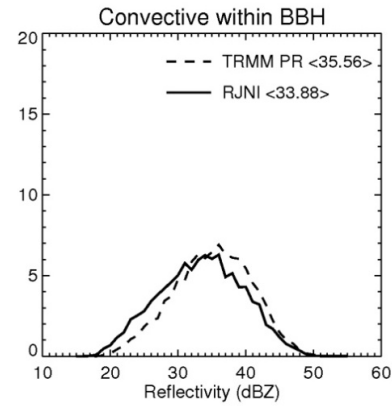
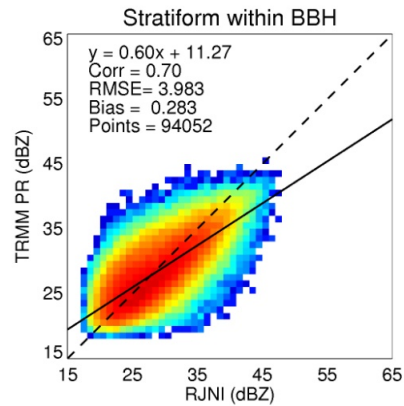
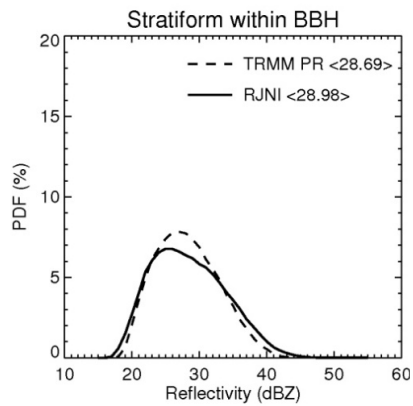
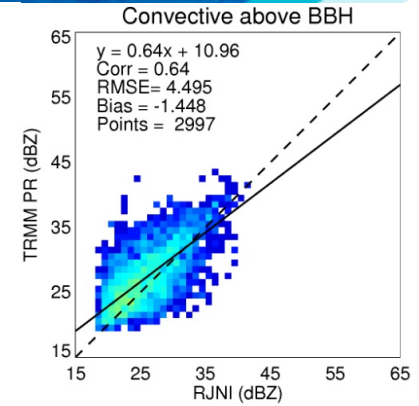
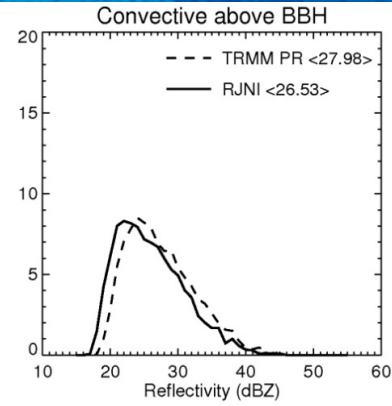
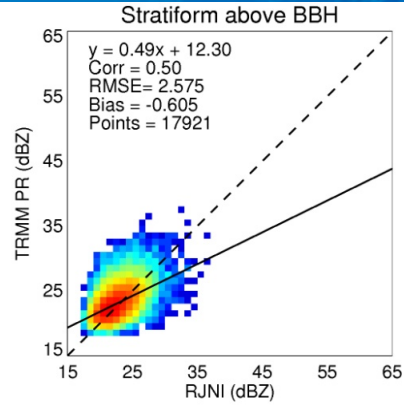
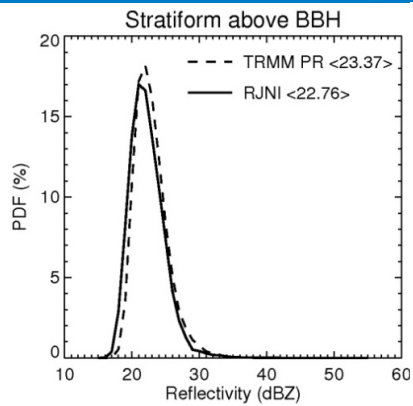




at RJNI

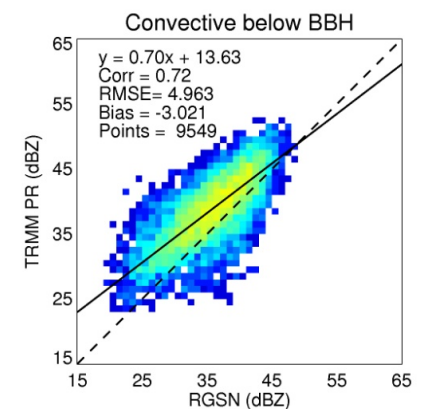
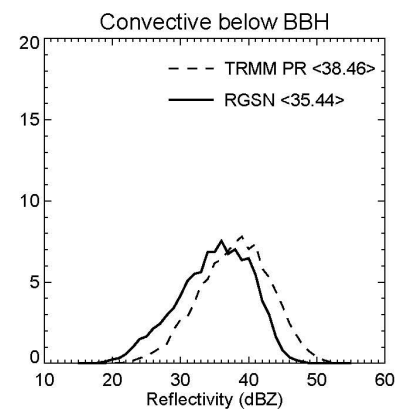
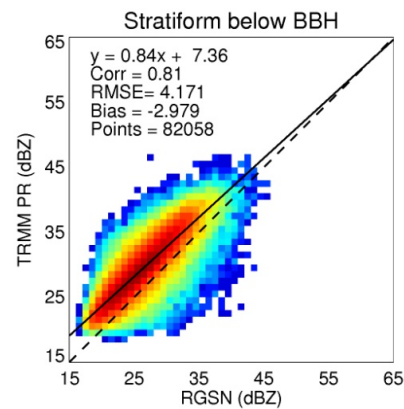
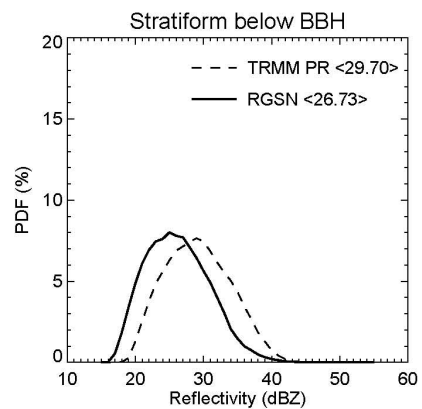
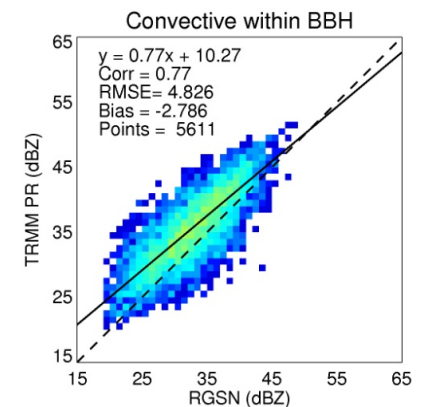
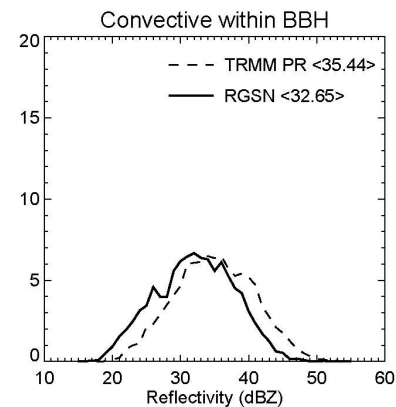
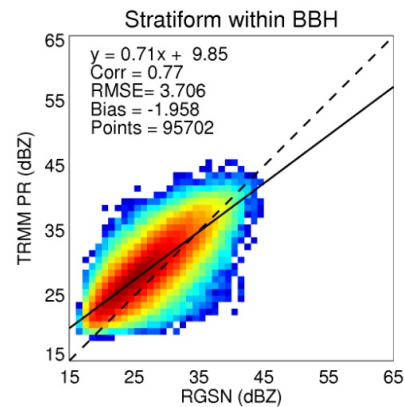
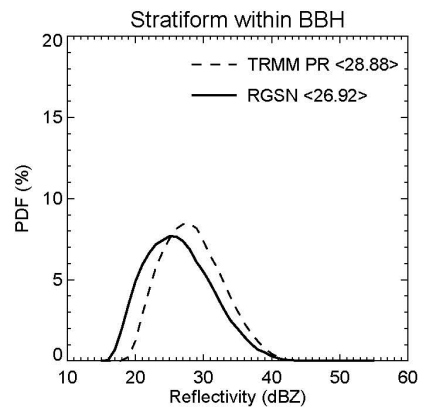
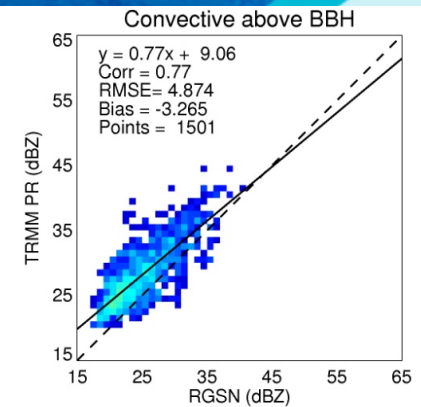
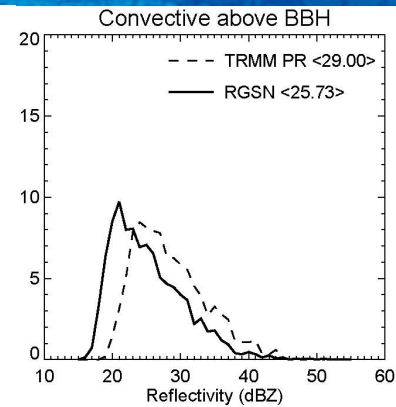
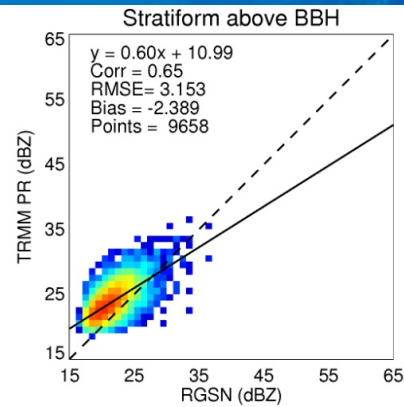
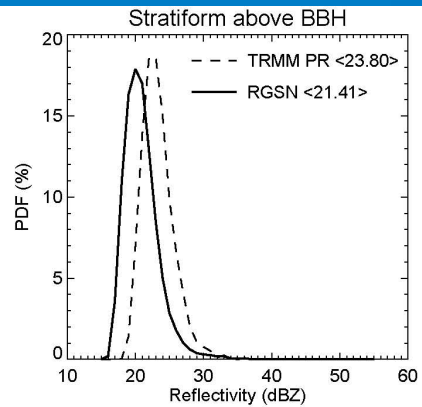
stratiform

convective



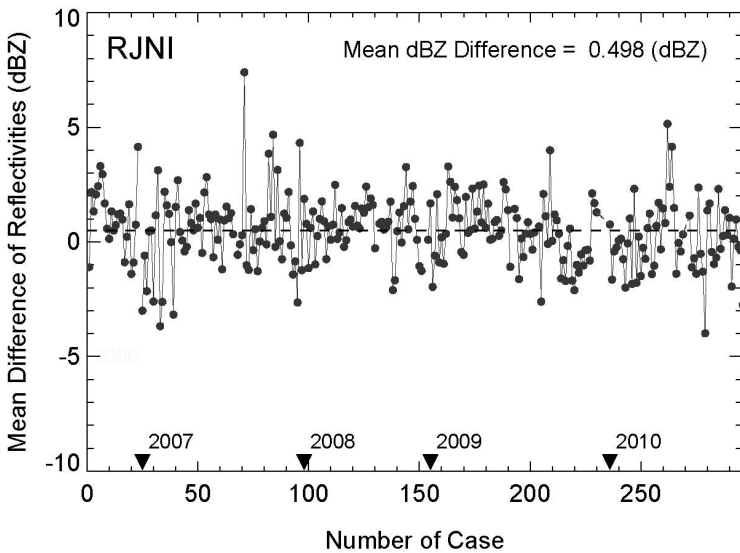
at RGSN stratiform

convective

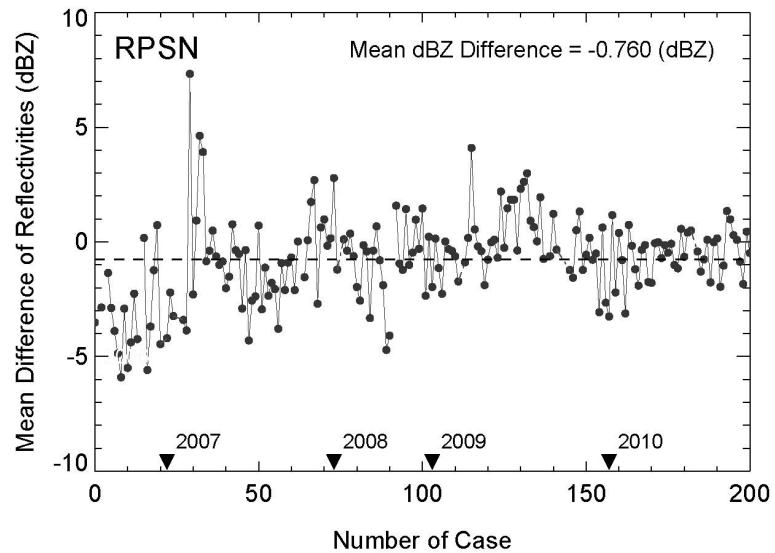


Mean dBZ Differences

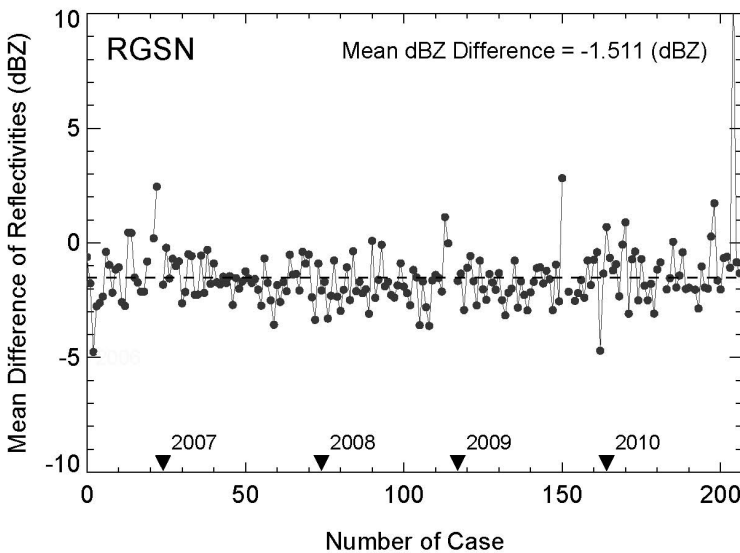
RJNI



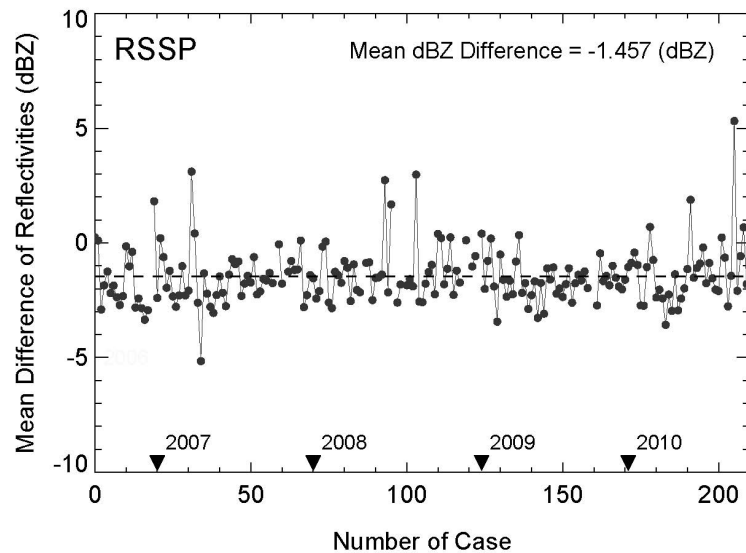
RPSN



RGSN

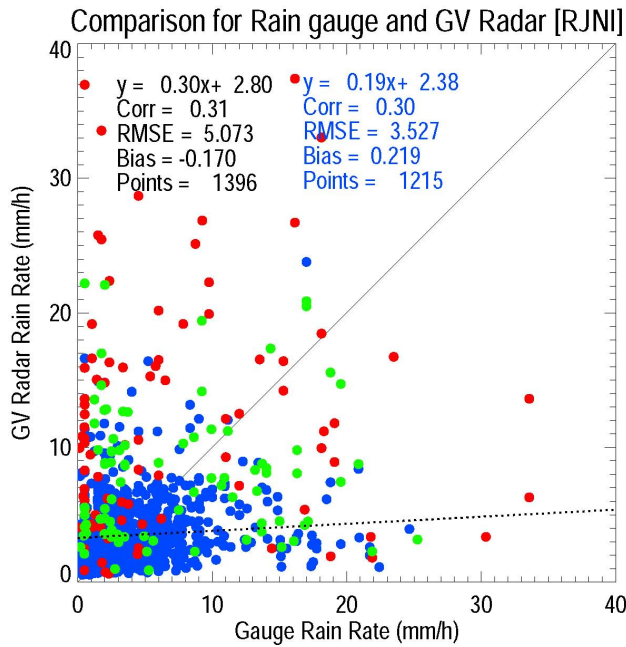


RSSP

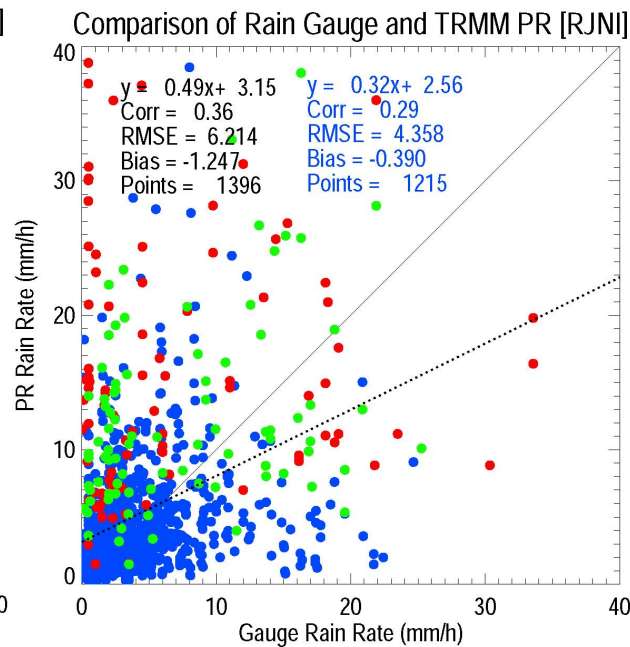


Scatter Plots for Rain Rates at RJNI

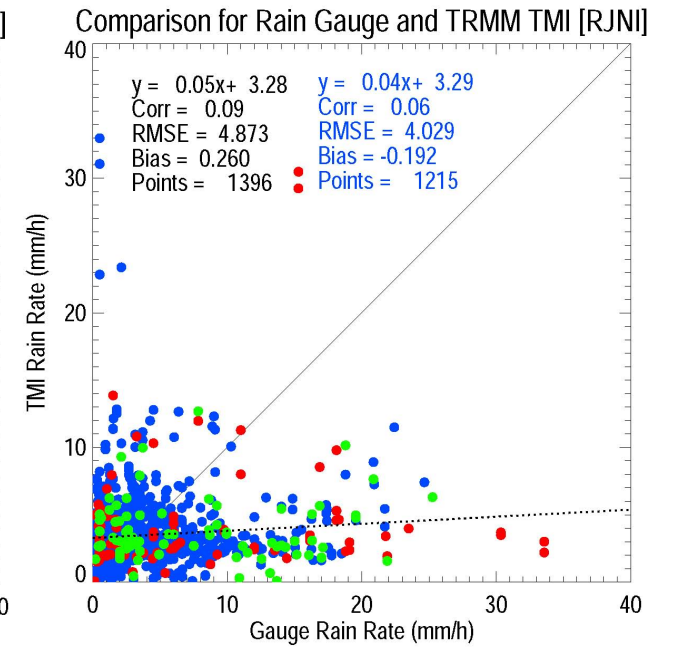
Gage – GV Radar



Gage – PR



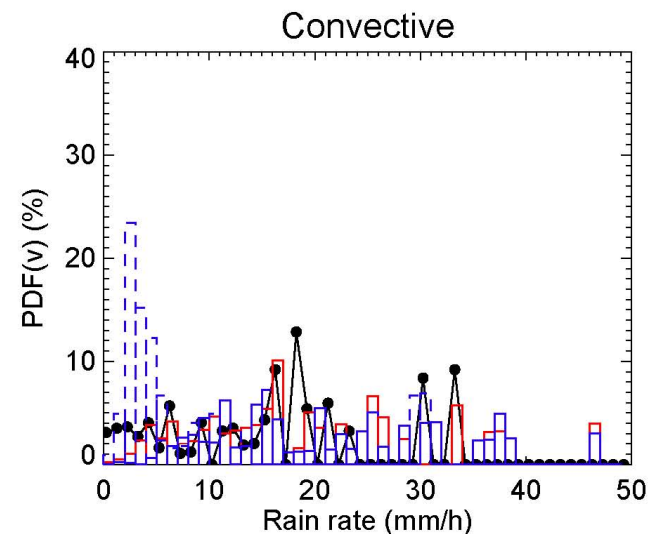
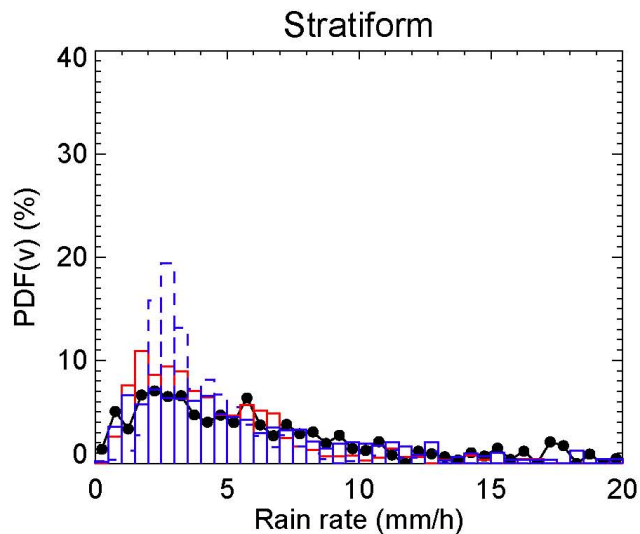
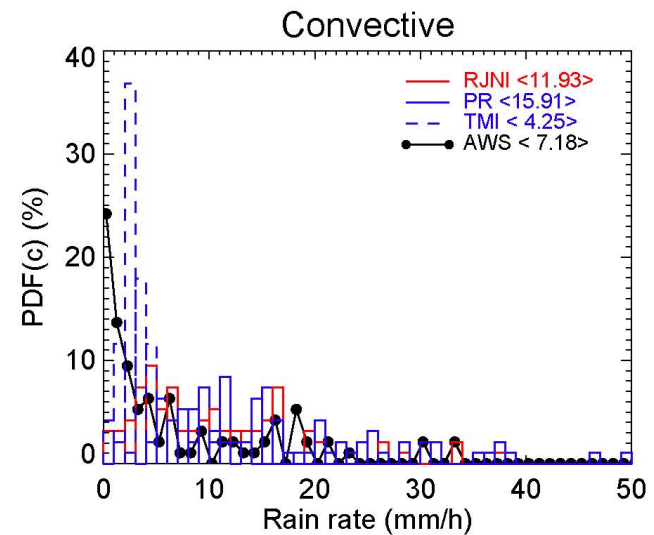
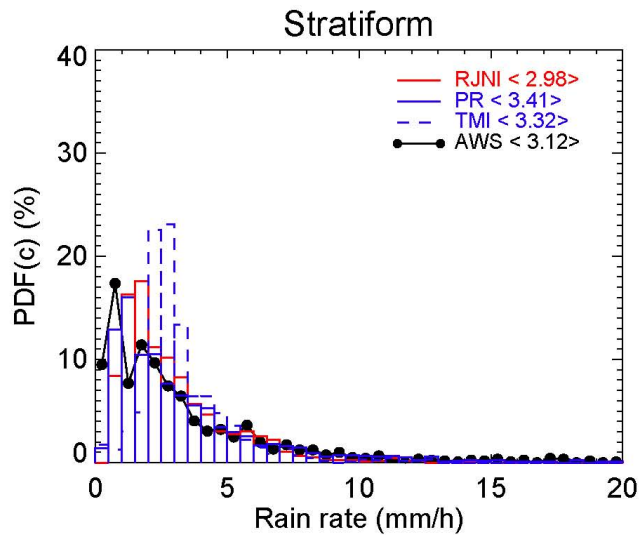
Gage – TMI



- Stratiform
- Convective
- Mixed



PDFs for Rain Rates at RJNI

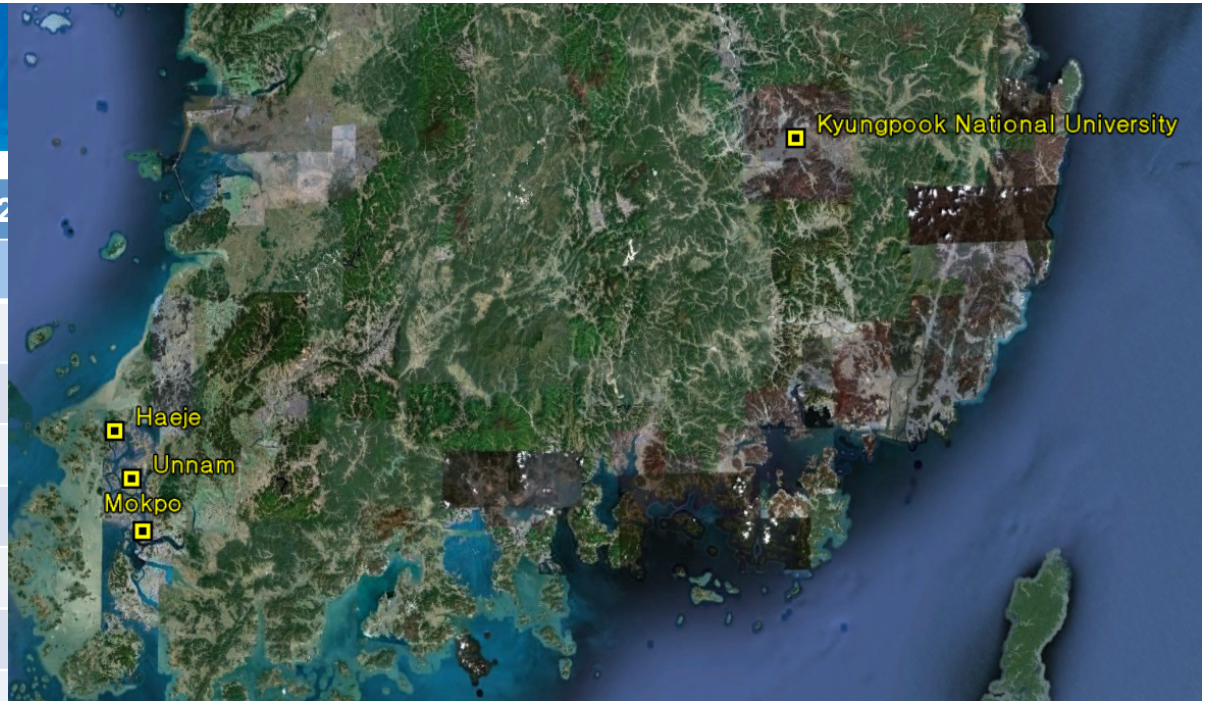


GPM Ground Validation

Investigating Characteristics of Rain over Korea

Data

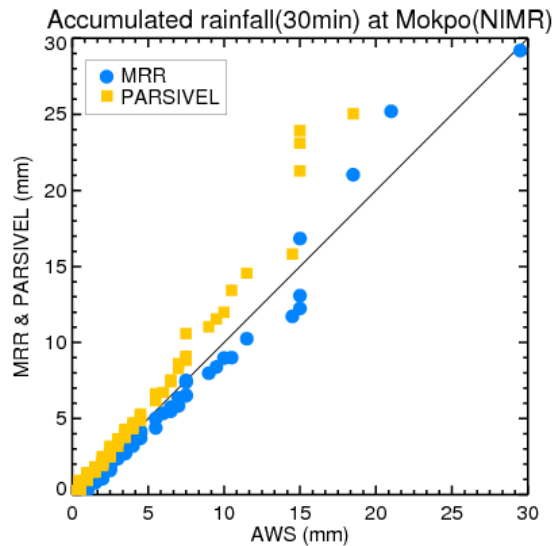
Instrument		
		2
MRR	Mokpo	0
	Unnam	0
	Haeje	0
	KNU	
PARSIVEL	Mokpo	0
	Unnam	
	KNU	



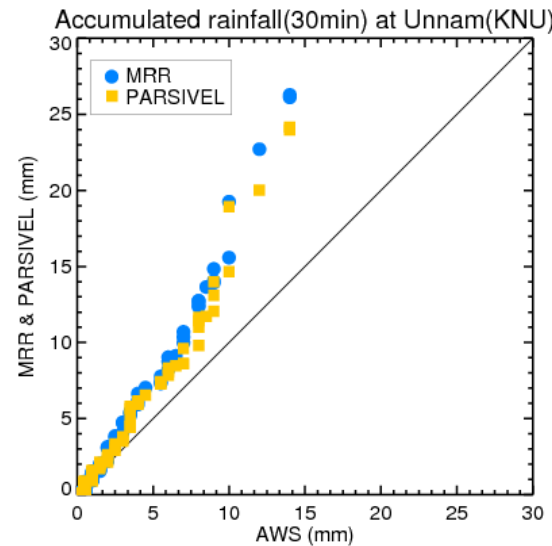
Instrument	MRR	PARSIVEL	TRMM/PR 2A25
Frequency	24.1GHz (K-band)	650nm	13.8GHz
Vertical res.	200m(200m~6000m) 30 levels	-	250m(0~20km) 80 levels
Hor. res.	-	-	4km
DSD Range	0.249 ~ 4.53mm	0.2 ~ 5mm (fluid type) 0.2 ~ 25mm (solid type)	-
Obs. Freq.	30 sec ~	30 sec ~	3~4/day around Korean peninsula

Accumulated Rain from MRR, PARSIVEL and AWS

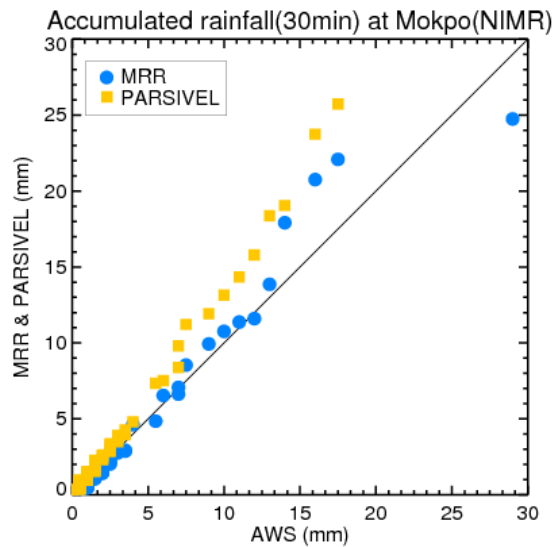
Mokpo
2009. 7
AWS : 465.5 mm



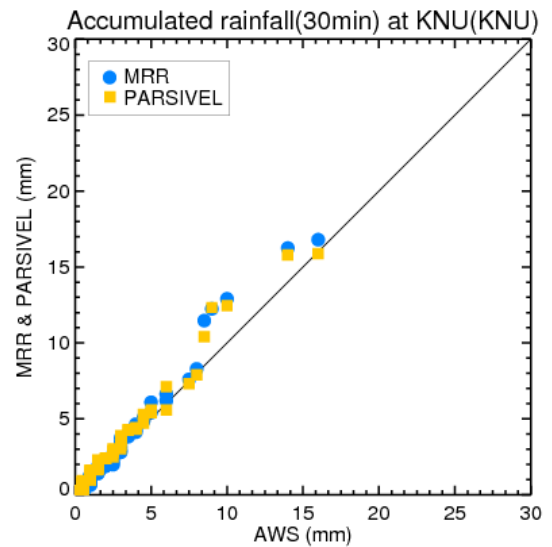
Unnam
2009. 7
AWS : 464.5 mm



Mokpo
2010. 7
AWS : 264 mm

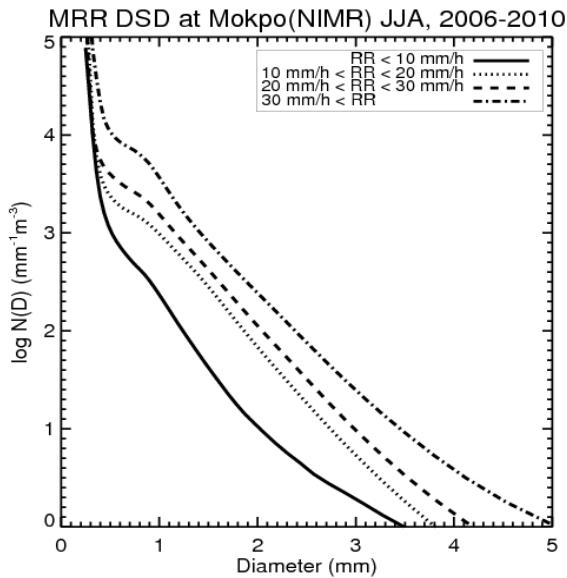


KNU
2010. 7
AWS : 247 mm

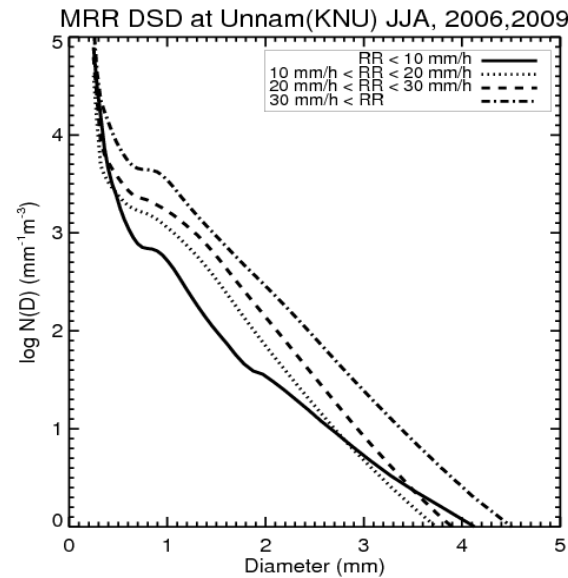


Drop Size Distribution from MRR for Summer

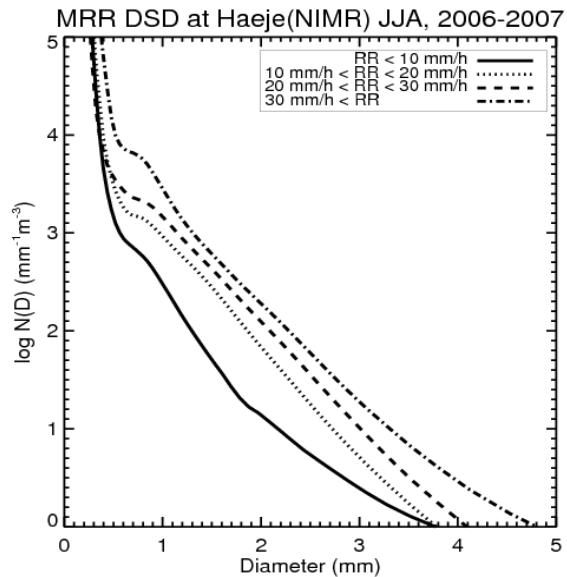
Mokpo
2006-2010



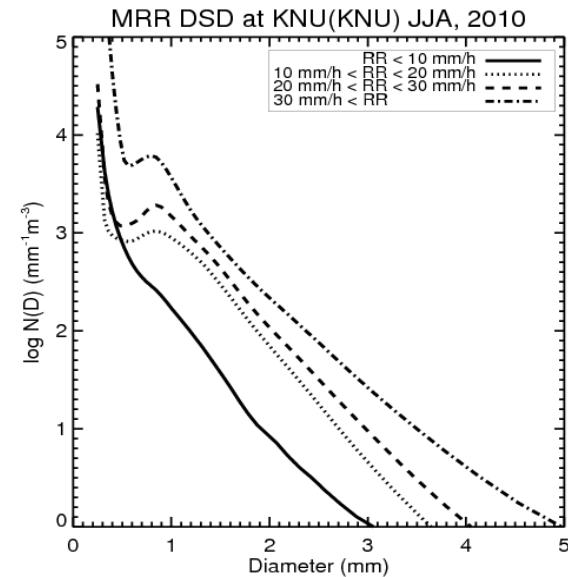
Unnam
2006, 2009



Heaje
2006-2007



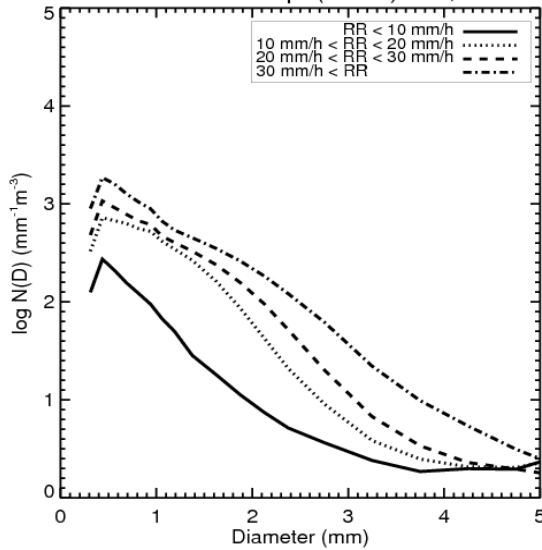
KNU
2010



Drop Size Distribution from PARSIVEL

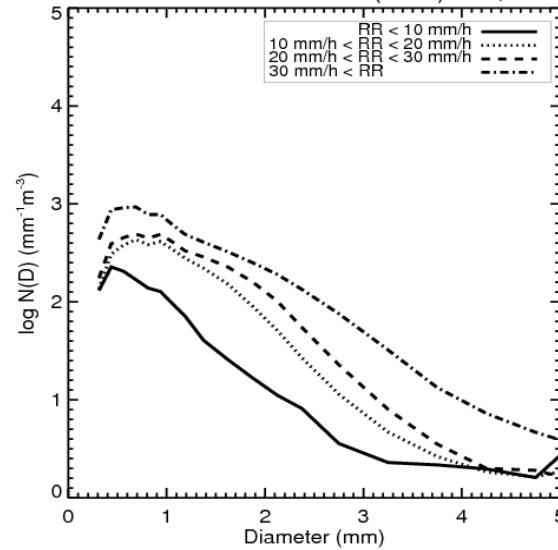
Mokpo
2006-2010

PARSIVEL DSD at Mokpo(NIMR) JJA, 2006-2010



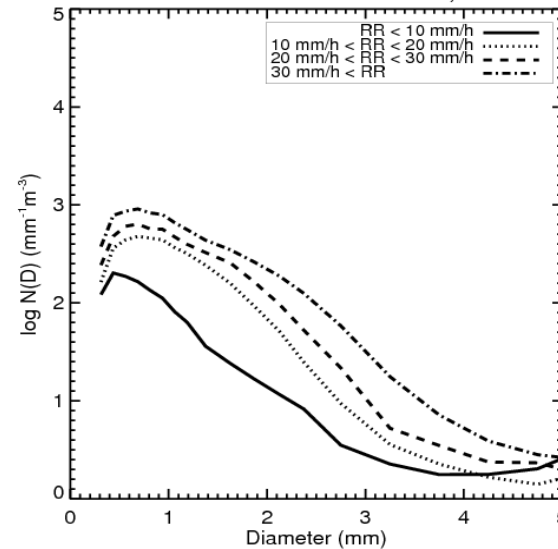
Unnam
2009

PARSIVEL DSD at Unnam(KNU) JJA, 2009



KNU
2010

PARSIVEL DSD at KNU JJA, 2010



Overview of VertiX

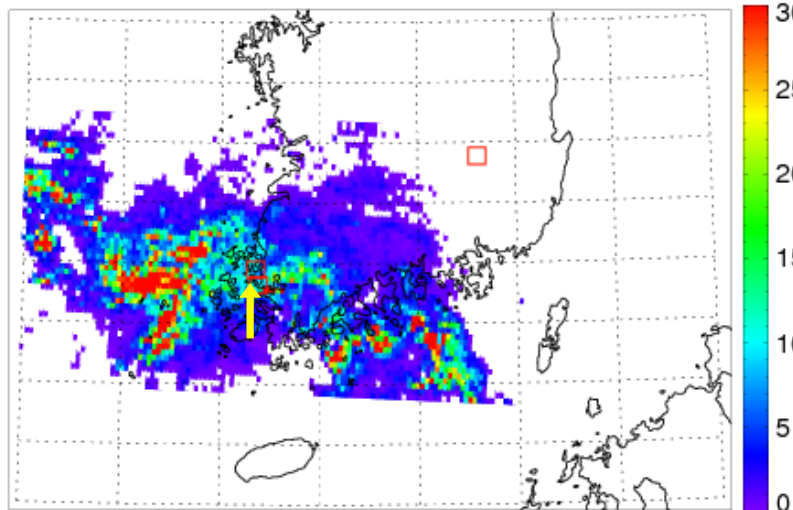
Instrument	VertiX Vertically pointing X-band Radar
Observation	Reflectivity, DSD, Fall Speed
Frequency	9.4GHz (X-band)
Vertical Resolution/ Max. Useful Range	45m /12 km
Typical Sampling Time	2 s



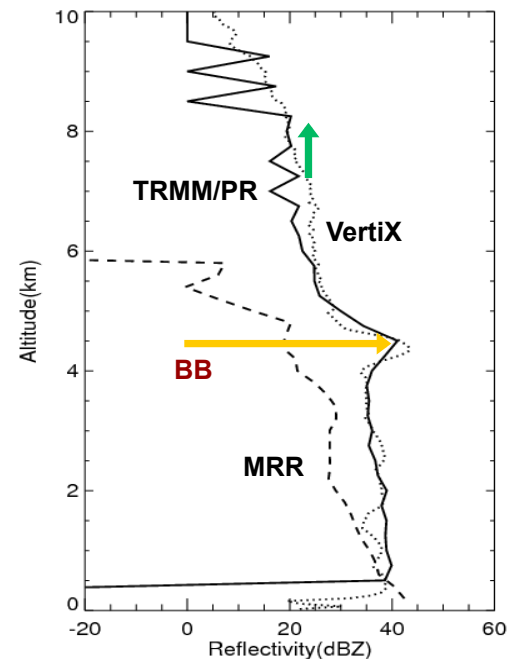
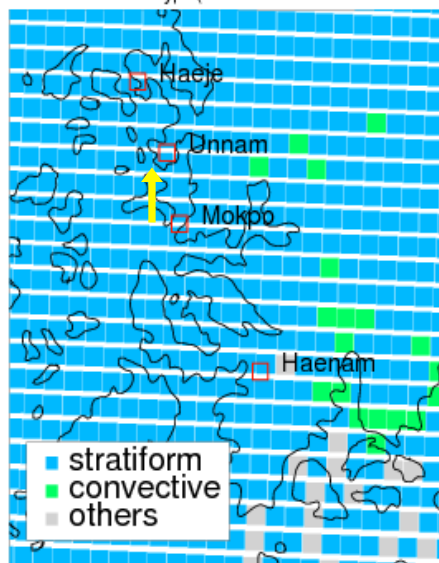
Provided by KNU (Prof. K-W Lee)

Reflectivity Comparisons: PR, MRR, VertiX

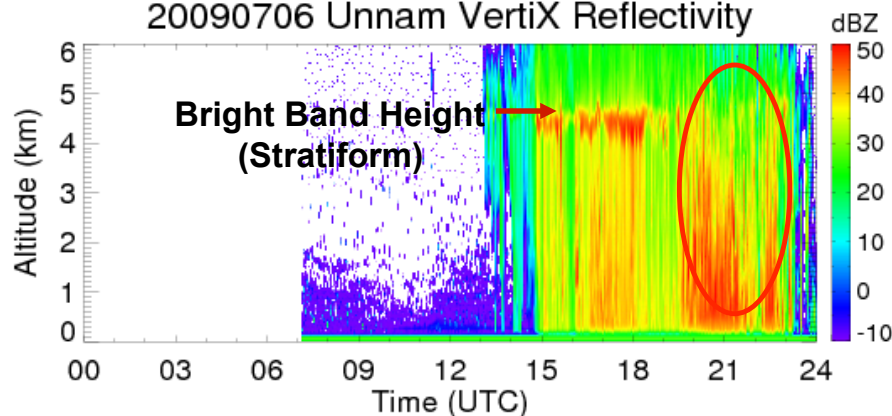
TRMM/PR Near Surface Rainrate(mm/h)
20090706 1646UTC 66315



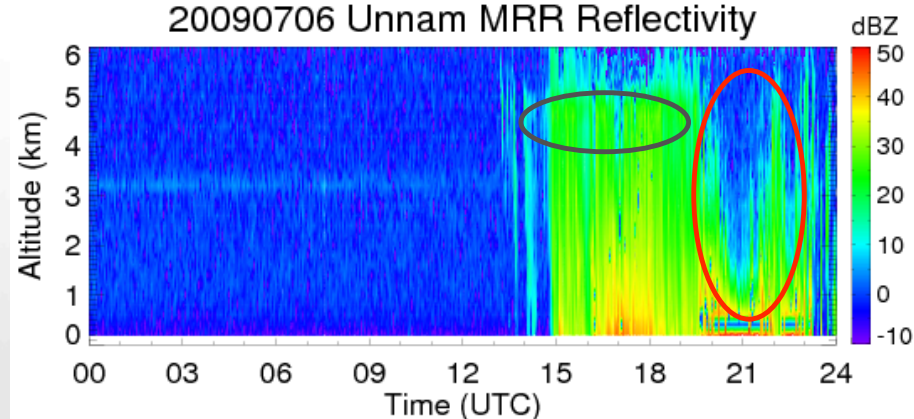
TRMM/PR RainType(20090706 1646UTC 66315)



20090706 Unnam VertiX Reflectivity



20090706 Unnam MRR Reflectivity



Plan for Replacement of the KMA Radar System

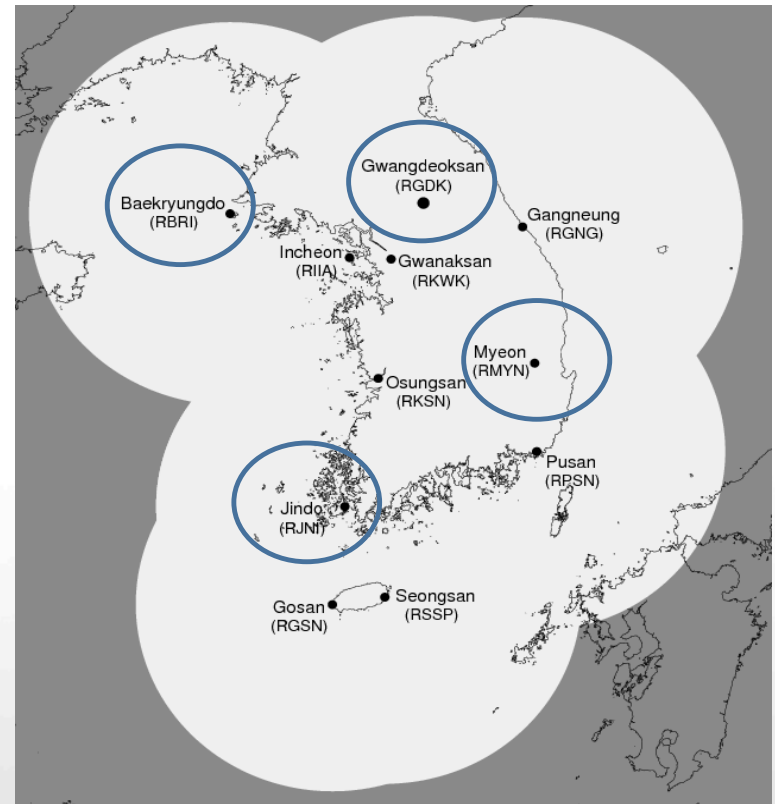


Project for Replacing the KMA Radar System

- ❖ Replace all of 10 operational single-pol radars **with S-band dual-pol radars** in a single model over the period of 2011-2016

❖ Project Details

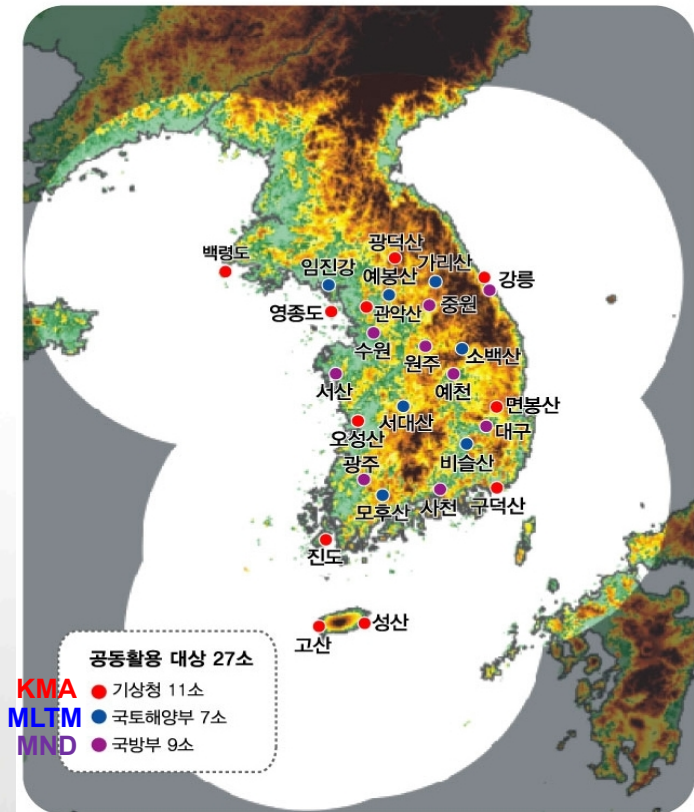
Year	Site
2011	RBRI
2012	RJNI
2013	RGDK
2014	RMYN
2015	RKWK, RPSN, RGSN
2016	RSSP, RKSAN, RGNG



Plan for Sharing Radar Data

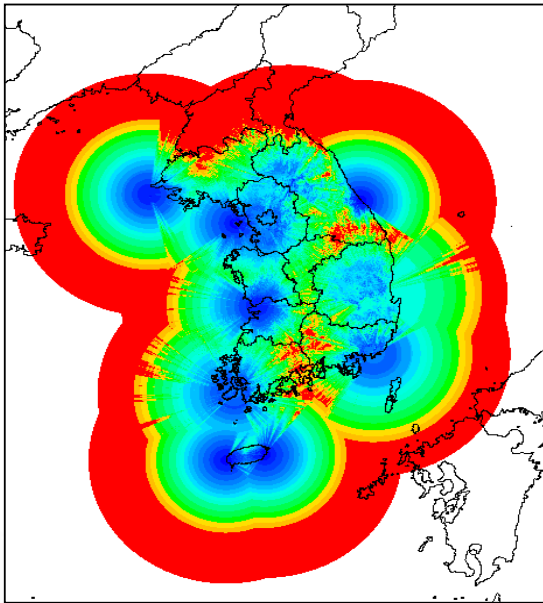
- ❖ Different government agencies operate radars with different purposes.
- ❖ KMA has been trying to use the radars for maximizing the radar coverage over the Korean peninsula.
- ❖ In June 2010, Ministry of National Defense(MND), Ministry of Land, Transport and Maritime Affairs(MLTM), and KMA have agreed to share radars.
- ❖ Current Status (Total: 27 radars)

Agency	Purpose	# of Radars
KMA	Weather Forecasting	11
MLTM	Monitoring of rain in the river basin	7
MND	Weather Monitoring in the Runway	9



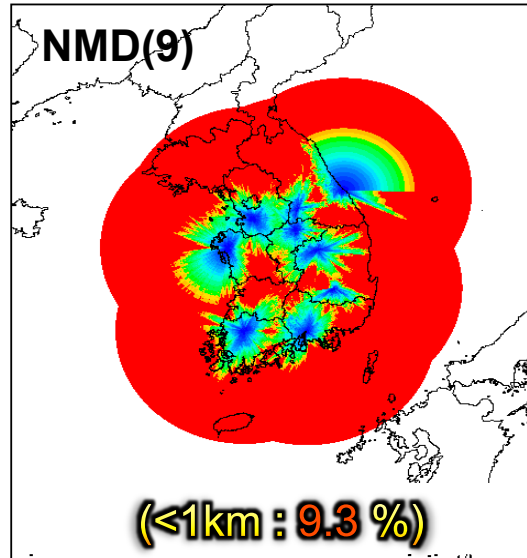
Impact of the Integrated Radar System

KMA(11)



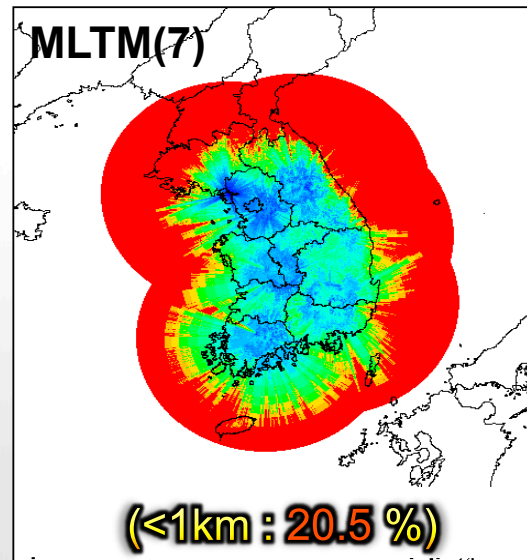
(<1km : 27.8 %)

NMD(9)



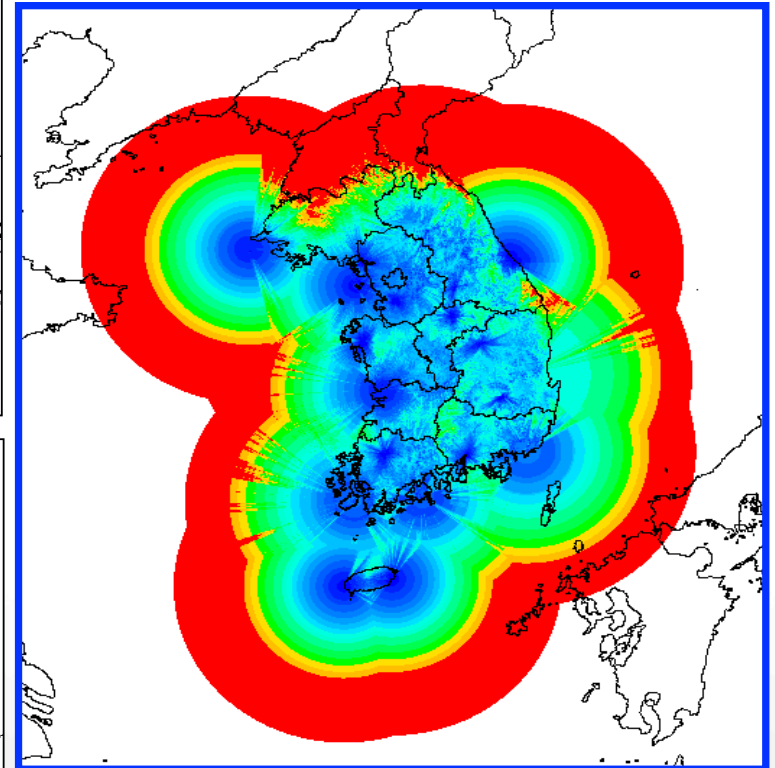
(<1km : 9.3 %)

MLTM(7)



(<1km : 20.5 %)

After Integration(27)



Summary

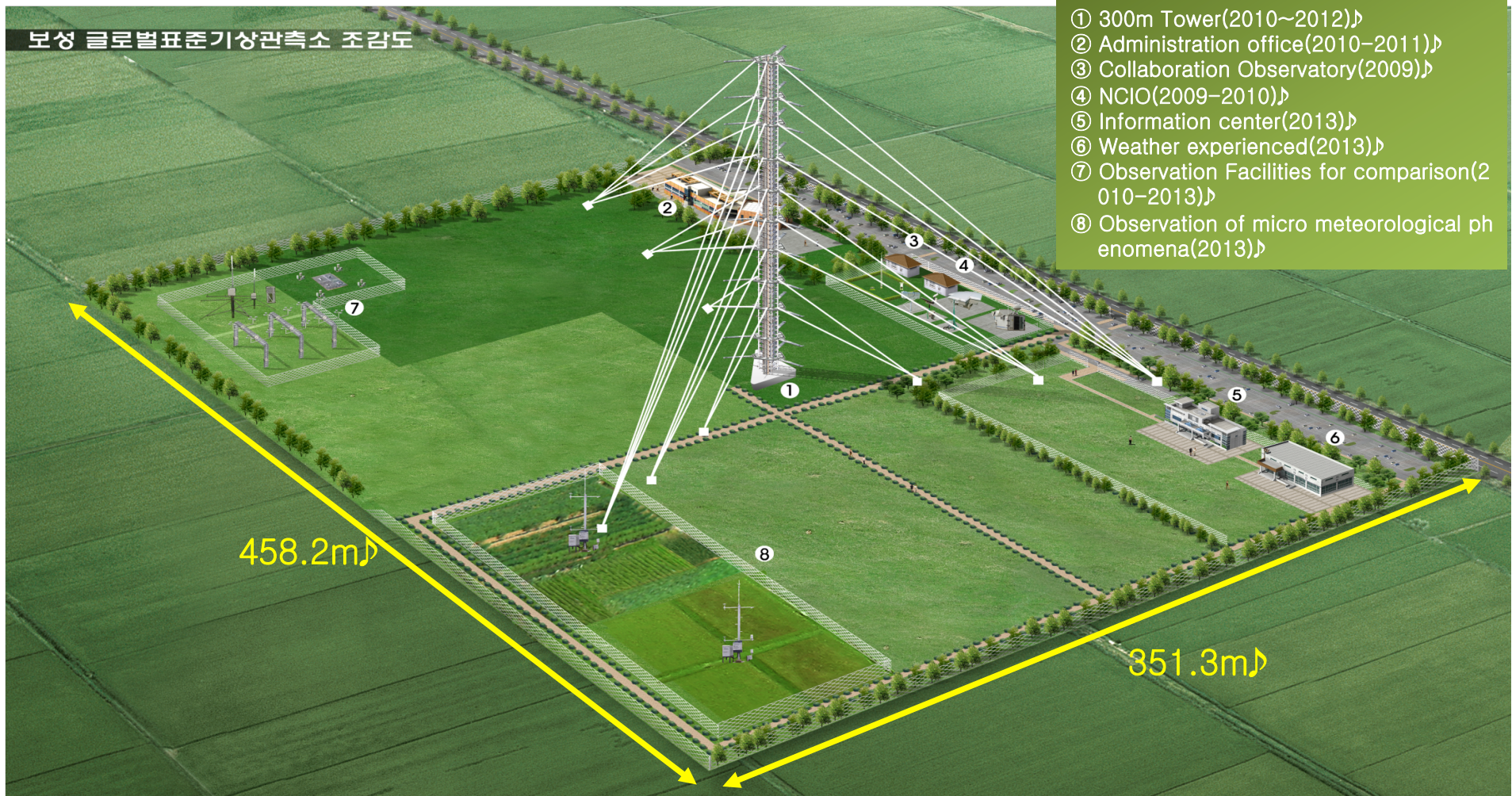
- ❖ KMA has performed reflectivity comparisons by using the 4-KMA ground based S-band radars as a part of the direct validation of the GPM.
 - Prototype of the GPM GV over the Korean peninsula
 - 4-year(2006.8-2010.8) data have been used for the comparison
 - Rain rate comparison between gages, ground based radars, TMI and PR has also been performed for the same period.
- ❖ KMA is working on characterizing the structure of precipitation by using in-situ measurements such as MRR, Parsivel and Vertix.
- ❖ KMA cooperates with JAXA on GPM GV to strengthen the GPM activity over the E. Asia region.
- ❖ Future Work
 - To extend the cooperating area with NASA
 - Error characterization of the precipitation over Korean peninsula
 - To use the TRMM V7 data for the comparison



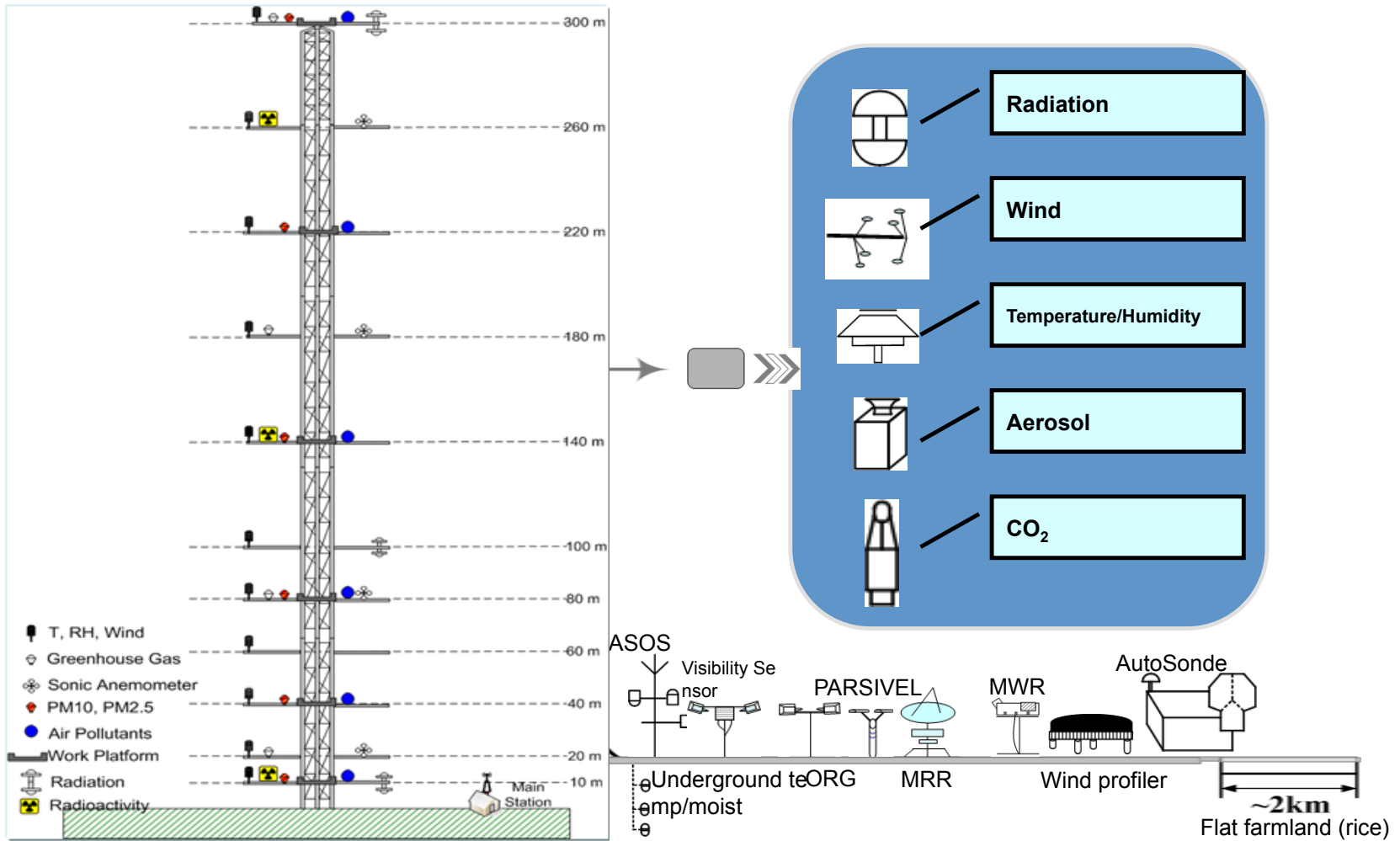


Boseong Global Standard Observatory

Station	Latitude	Longitude	Altitude above sea level	Area	Width	length	Complete
GSO	34.76N	127.21E	2.8m	154,495m ²	458.2m	351.3m	2013



300m weather observation tower



Boseong National center of intensive observation for severe weather(NCIO)♪

Equipments

Ka- and W-band Cloud radar (2011)



110m

31m

Observation field



Windprofiler



CLM ORG PARSIVEL RDM



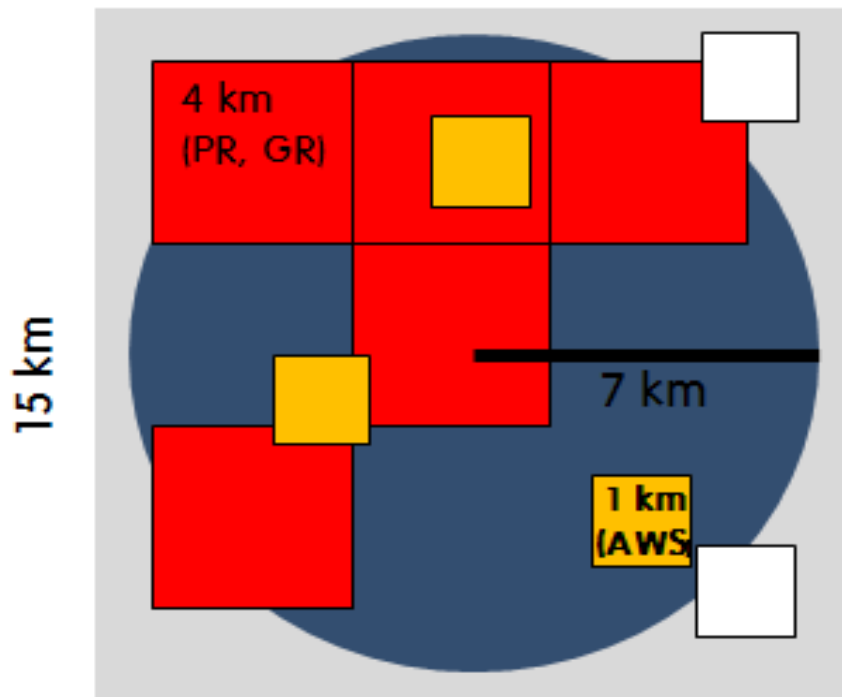
Autosonde



Thank You for Your Attention !!!

Rules for collocation and assigning cloud types

15 km (TMI footprint)



Within a TMI pixel,

n = ratio of pixels assigned as convective type in PR 2A25

- stratiform : $0 \leq n \leq 0.3$
- mixed : $0.3 < n \leq 0.7$
- convective : $n > 0.7$