2016 NASA PMM Science Team Meeting, October 24-28, 2016, Houston, TX, USA

The GPM Validation Activity over Korea and ICE-POP 2018

Geun-Hyeok Ryu

&

Nowcast supporting team

Satellite Analysis Division, NMSC/KMA

25 October 2016

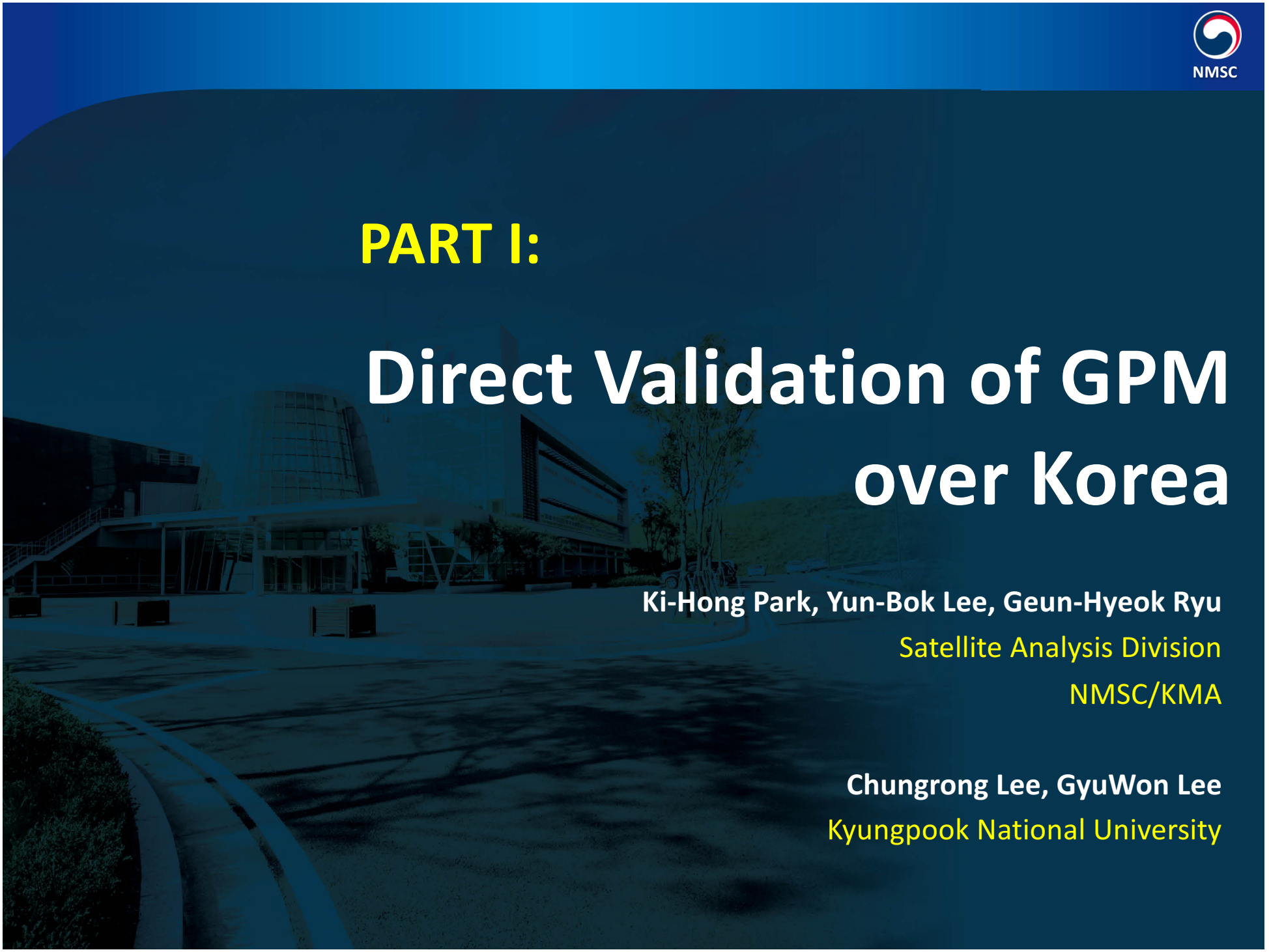
Korea Meteorological Administration

Outline

NMSC

- **Direct Validation of GPM over Korea (Part I)**
  - 3-year summer time Ground validation using VN over Korea
  - Quick evaluation of algorithm improvement from V3 to V4 over Korea
  - Application of DFS(Digital Forecast System) Coordinates to GV

- **ICE-POP 2018 (Part II)**
  - Introduction of ICE-POP 2018
  - Observation network over complex terrain
  - Implementation plan



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PART I:

Direct Validation of GPM over Korea

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Satellite Analysis Division
NMSC/KMA

Chungrong Lee, GyuWon Lee
Kyungpook National University

Validation Network over the Korea

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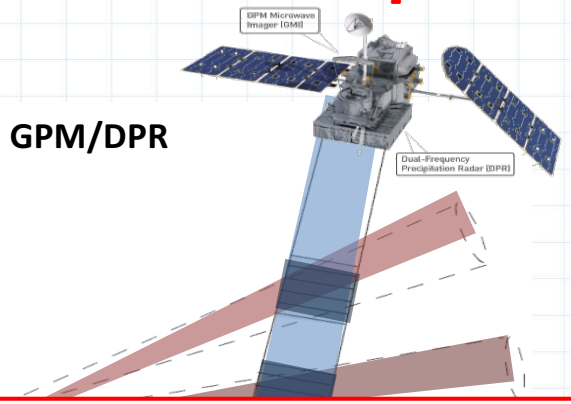
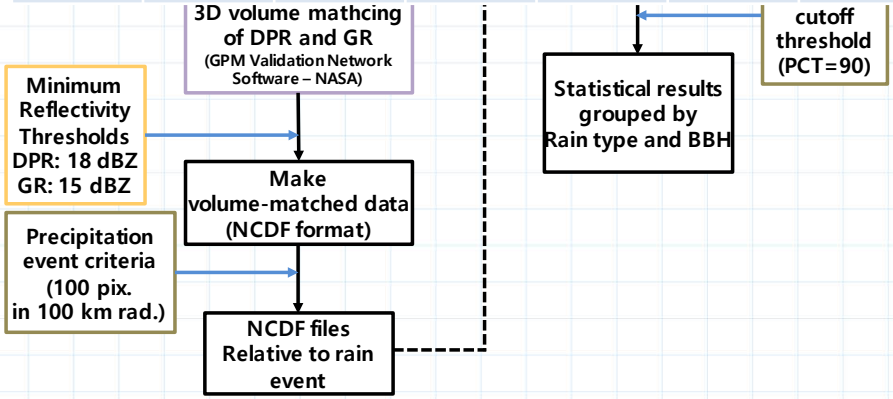
[Validation Network]

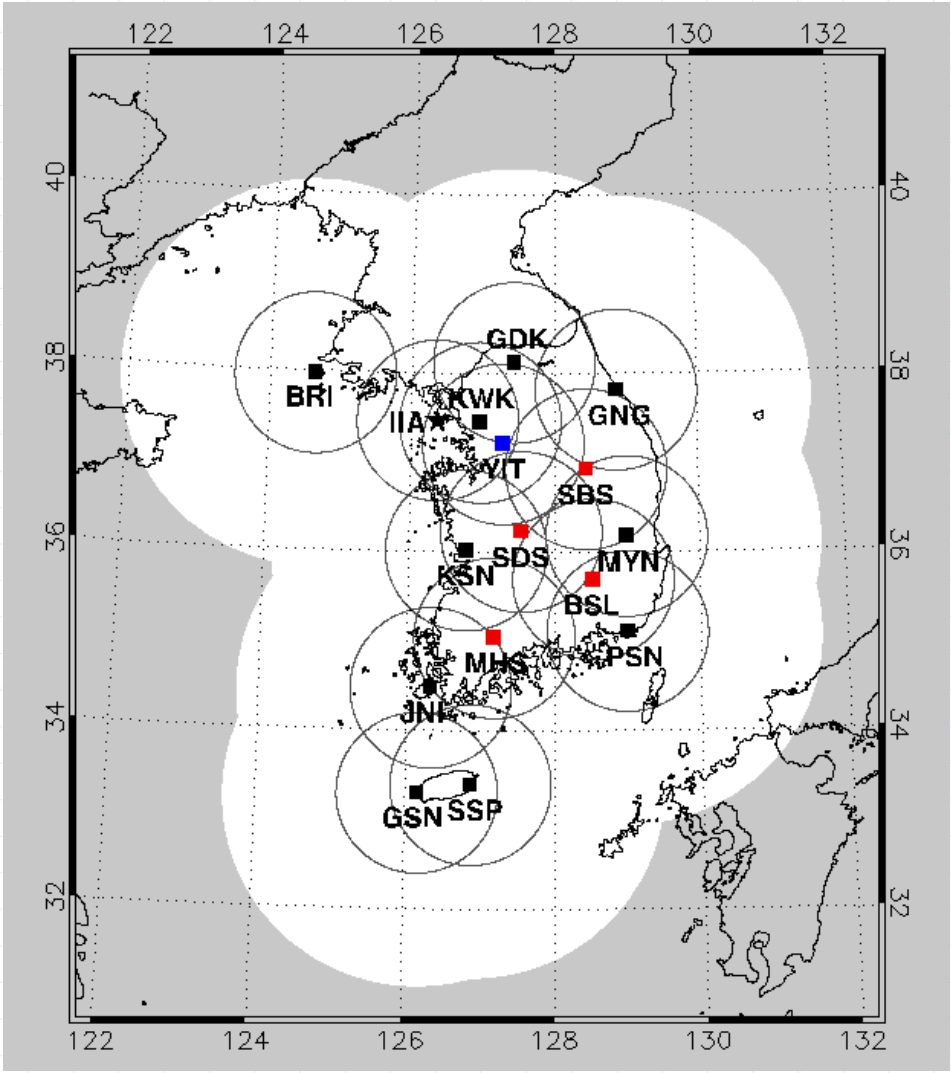


GPM/DPR

KMA started to replace the radar network to **S-band dual polarization radars** from 2013.

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





Black : KMA ground radar(11 site)

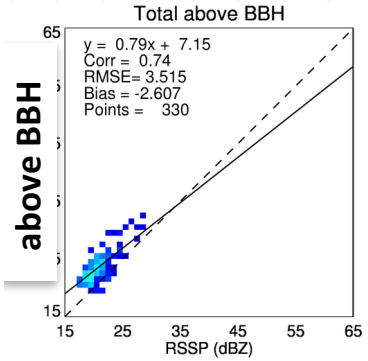
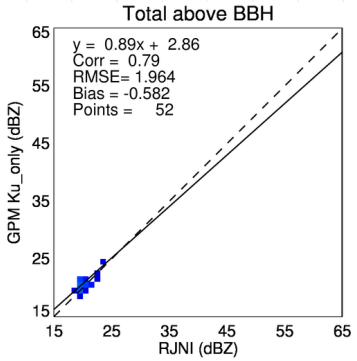
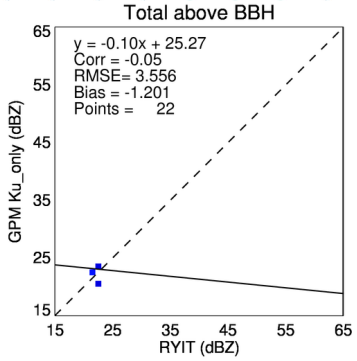
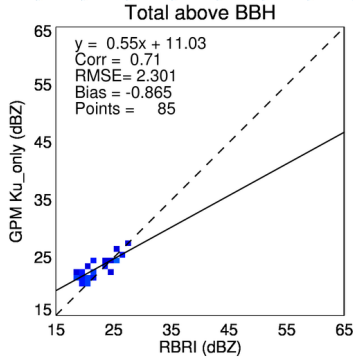
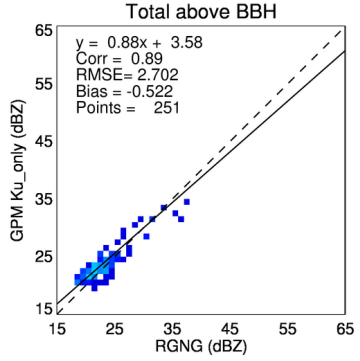
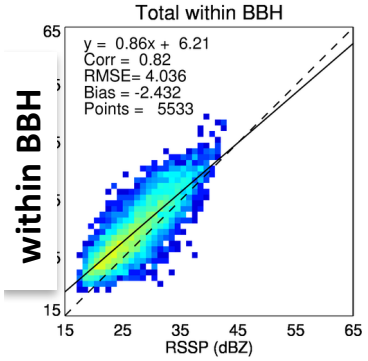
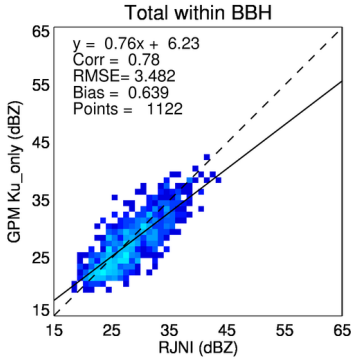
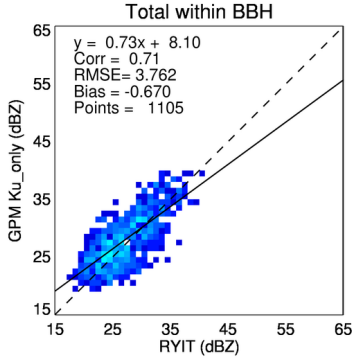
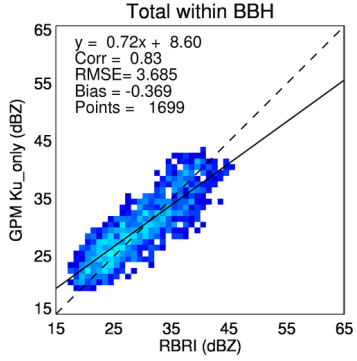
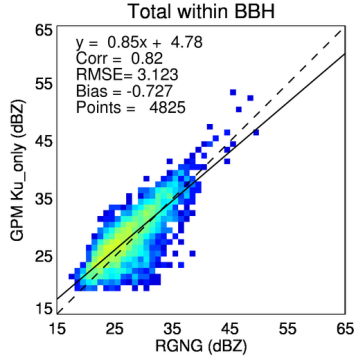
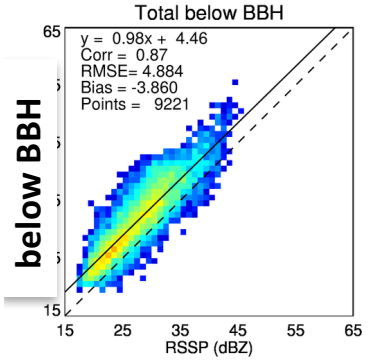
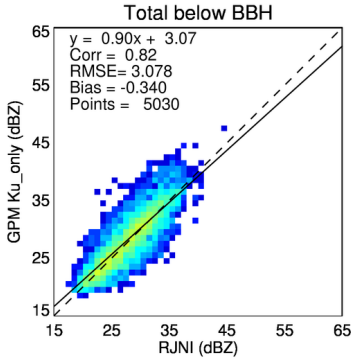
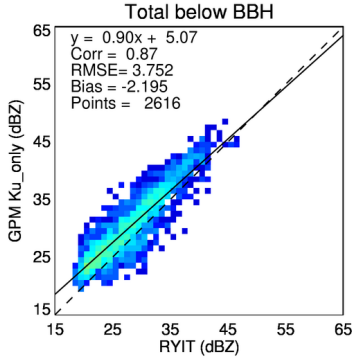
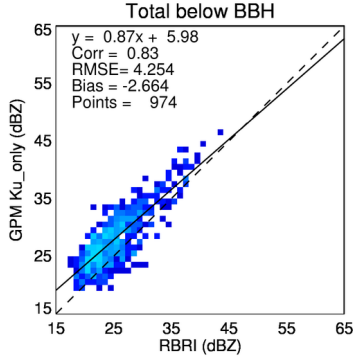
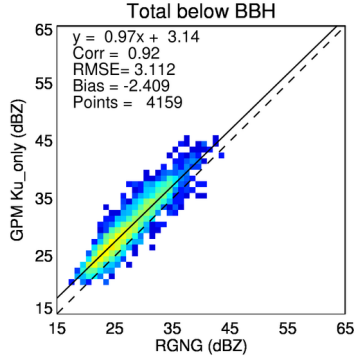
Blue : KMA test-bed(1 site)

Red : MOLIT ground radar(4 site)

Reflectivity Comparison Statistics (KMA sites)

NMSC

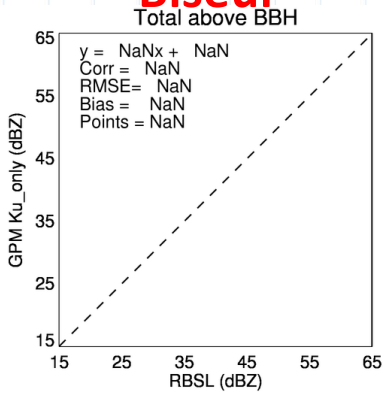
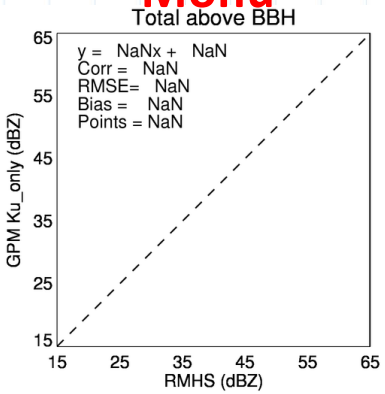
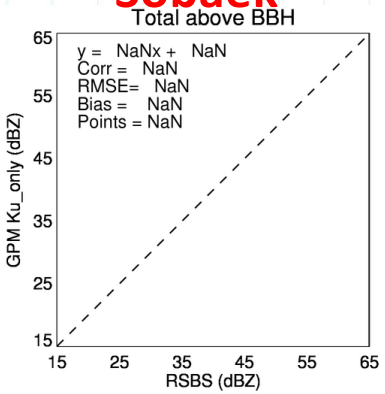
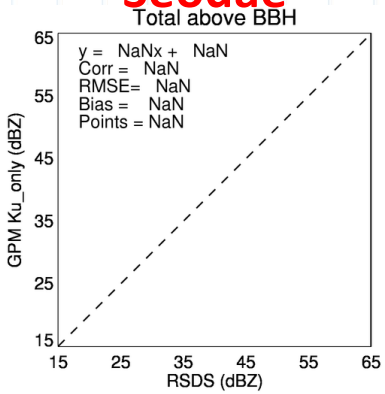
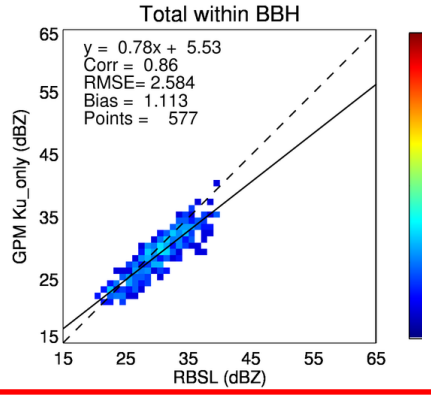
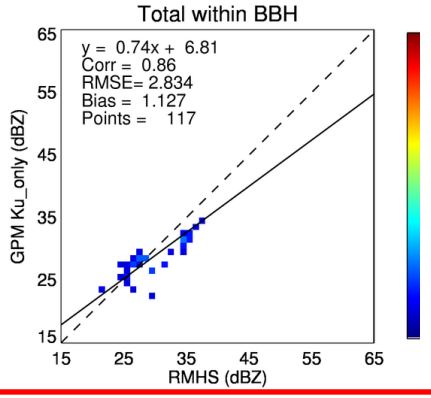
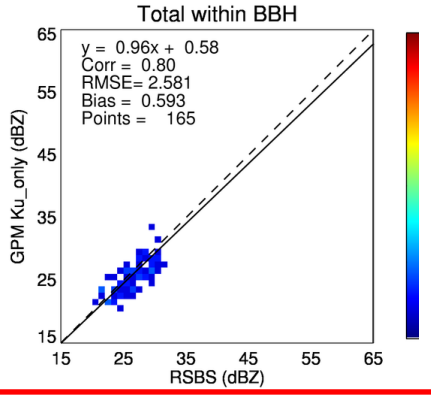
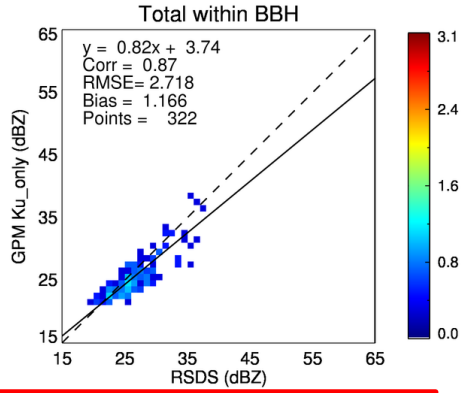
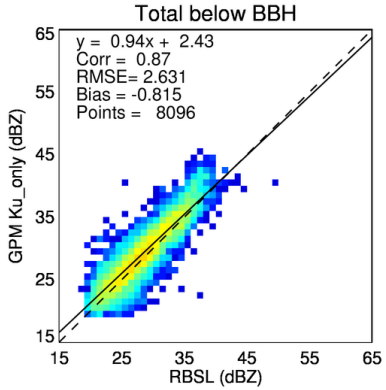
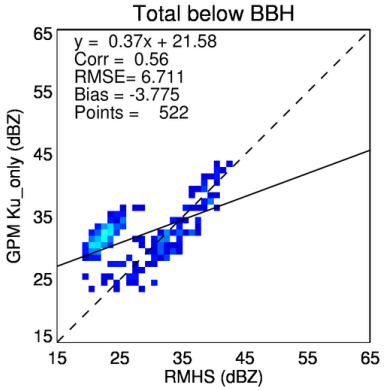
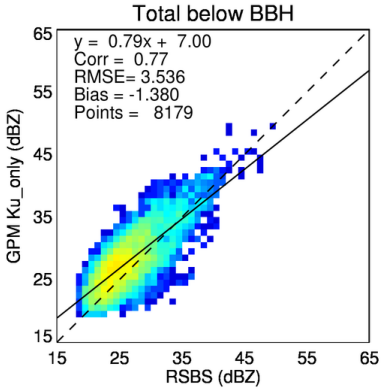
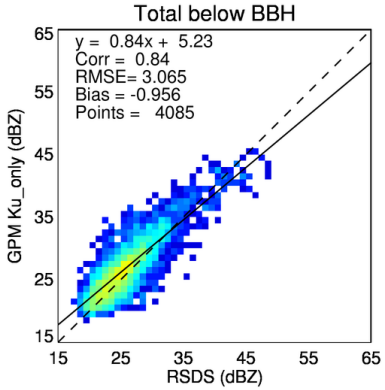
Period: JJA 2014 ~ 2016

	Seongsan	Jindo	Yongin	Baengnyeong	Gangneung
above BBH					
within BBH					
below BBH					

Reflectivity Comparison Statistics (MOLIT sites)

NMSC

Period: JJA 2015 ~ 2016

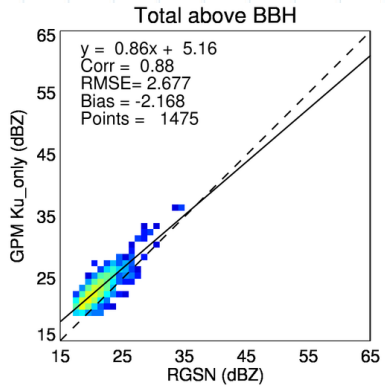
	Biseul	Mohu	Sobaek	Seodae
above BBH				
within BBH				
below BBH				

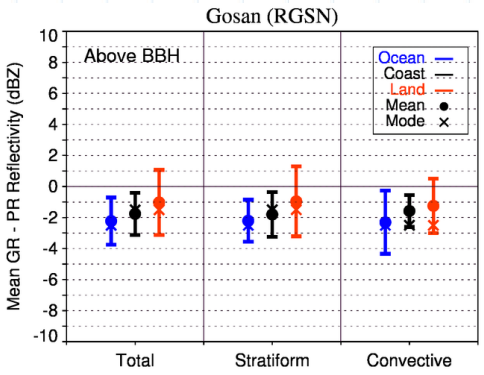
Quick Evaluation of Algorithm improvement @Gosan

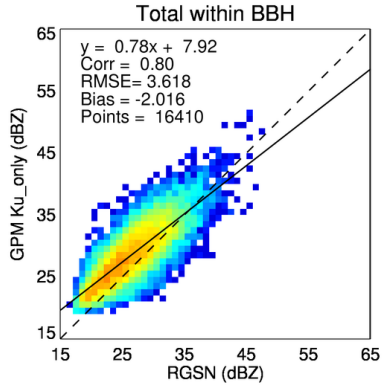
NMSC

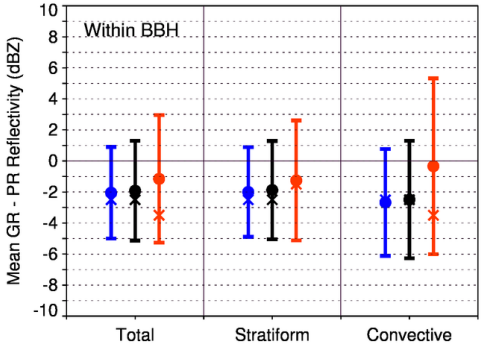
Period: Mar. 2014 ~ Feb. 2016

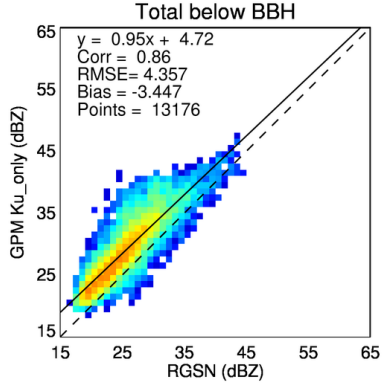
V3

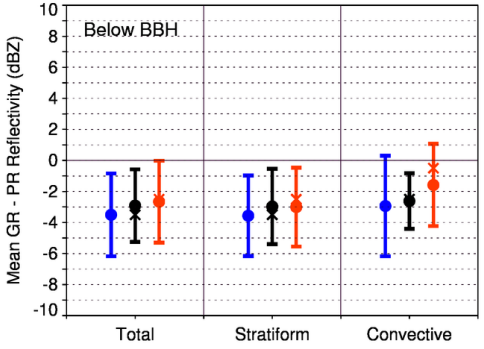




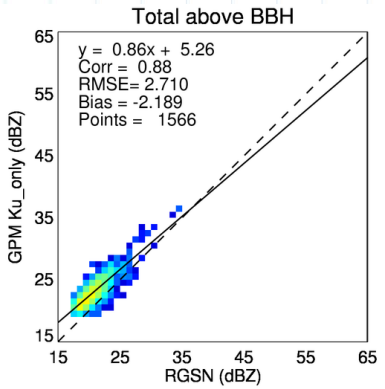


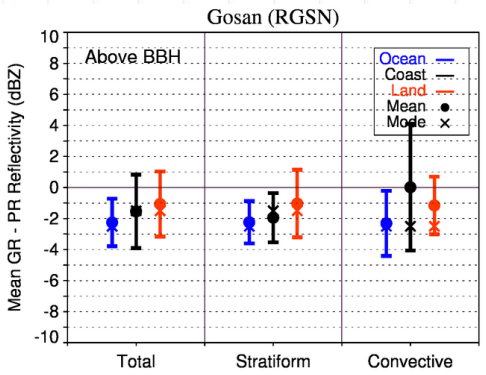


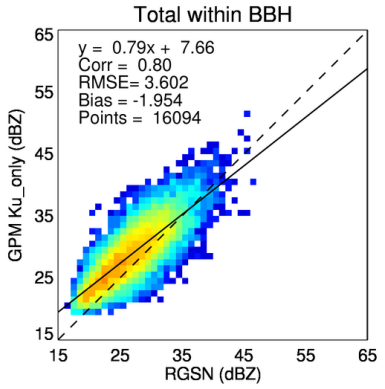


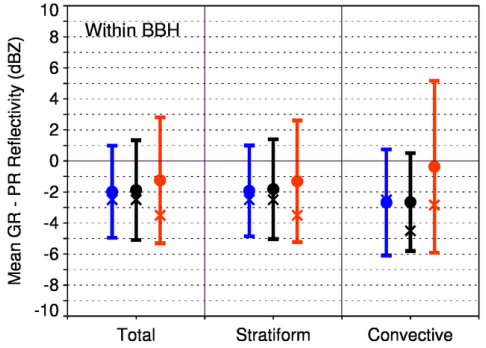


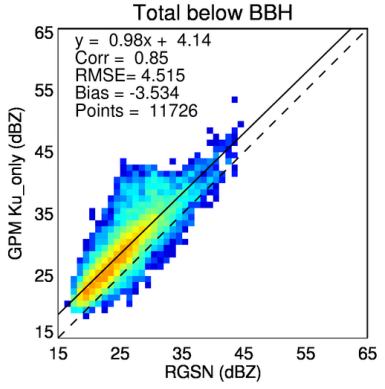
V4

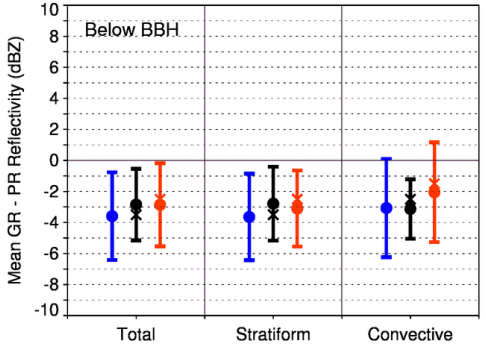












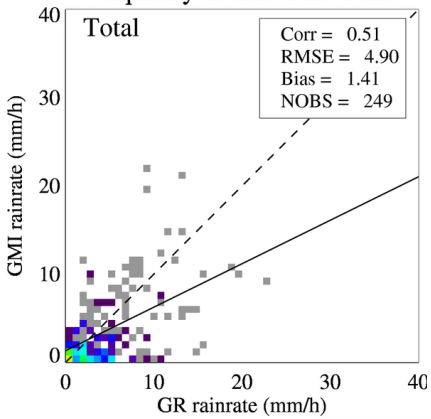
Quick Evaluation of Algorithm improvement @Gosan

NMSC

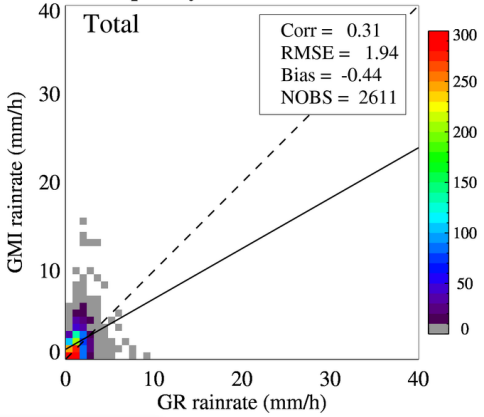
V3

GMI

Convective

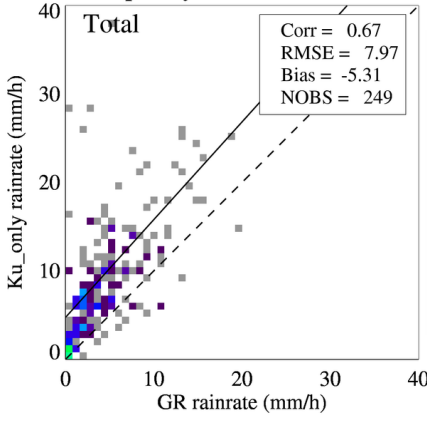


Stratiform



KuPR

Convective



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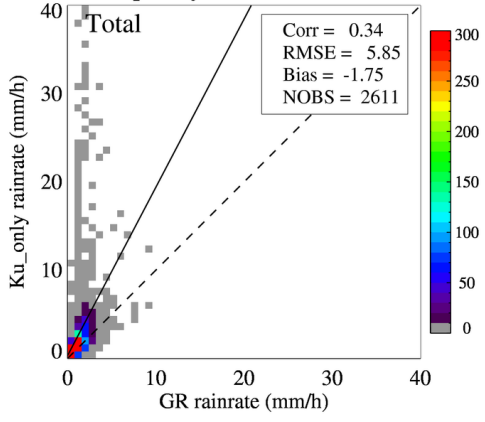
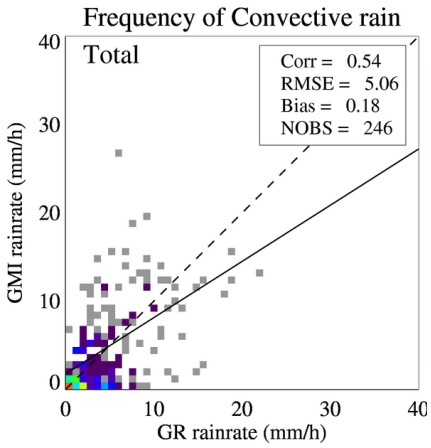
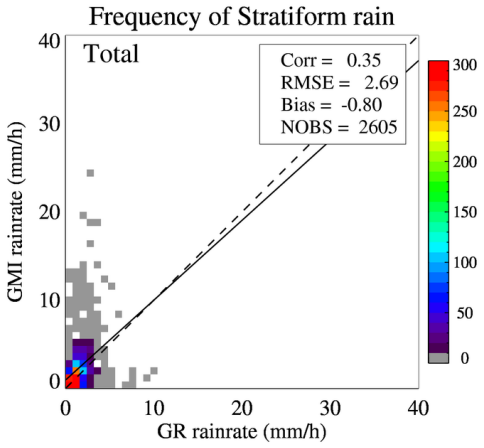


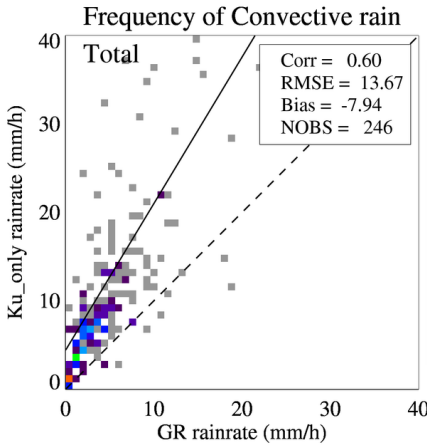
Slightly Better

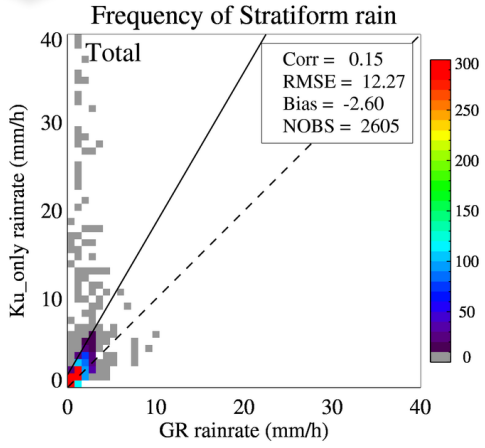
V4

Slightly WORSE







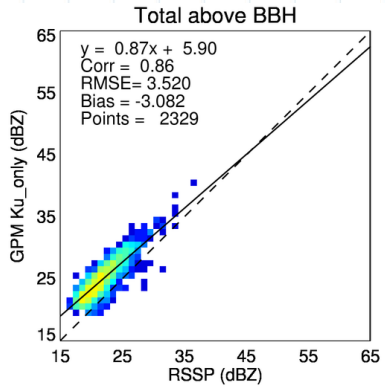


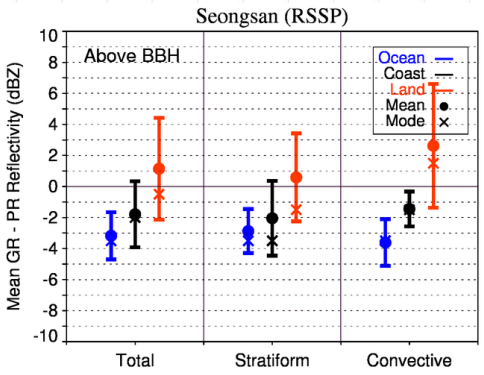
Quick Evaluation of Algorithm improvement @Sungsan

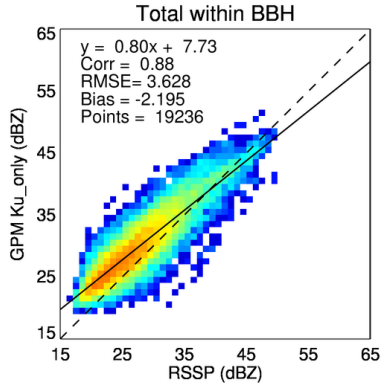
NMSC

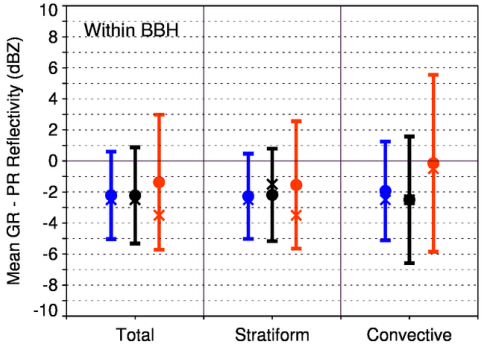
Period: Mar. 2014 ~ Feb. 2016

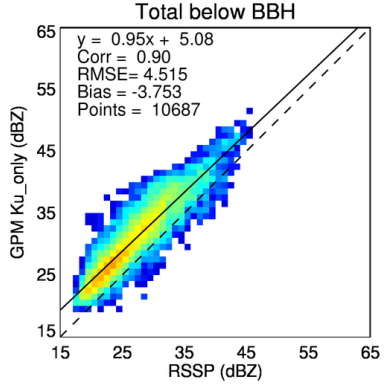
V3

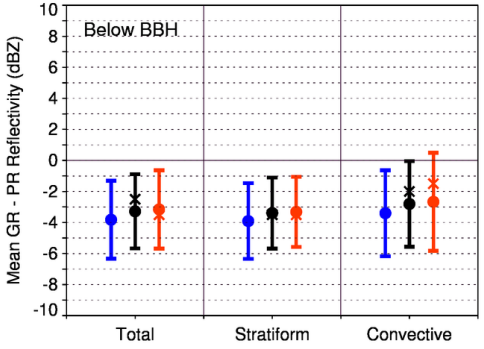




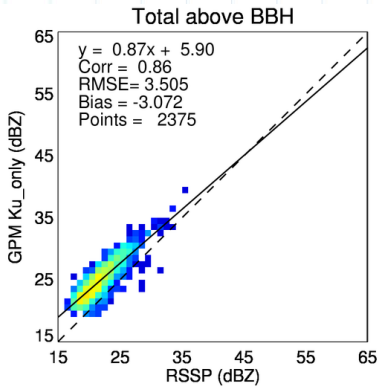


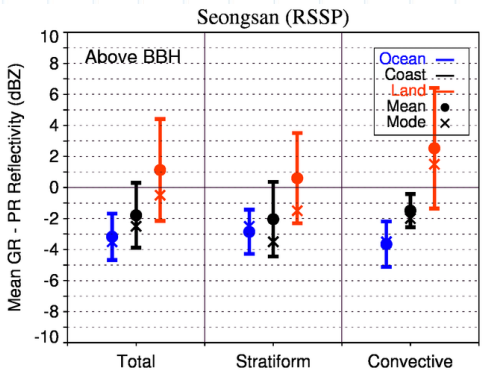


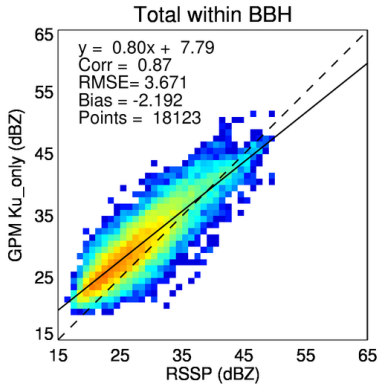


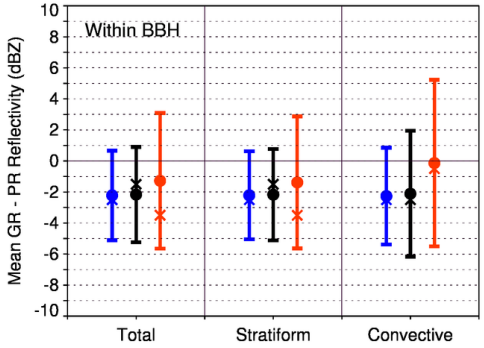


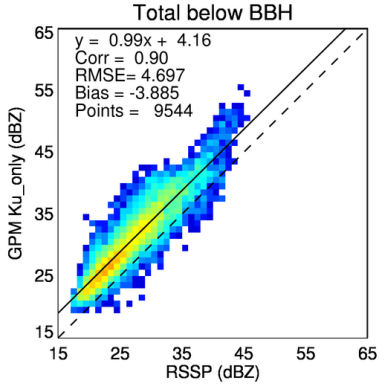
V4

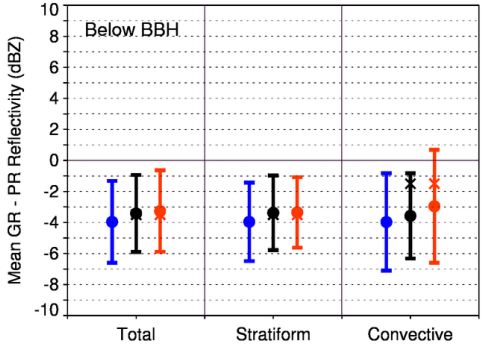












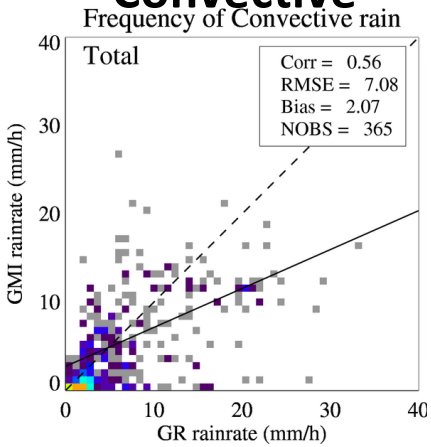
Quick Evaluation of Algorithm improvement @Sungsan

NMSC

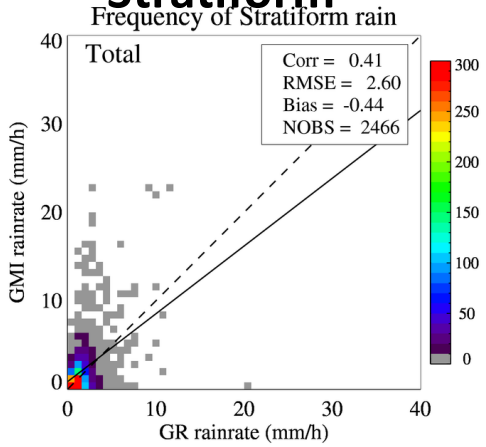
V3

GMI

Convective

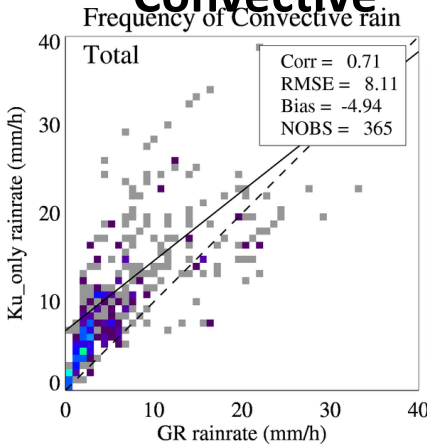


Stratiform

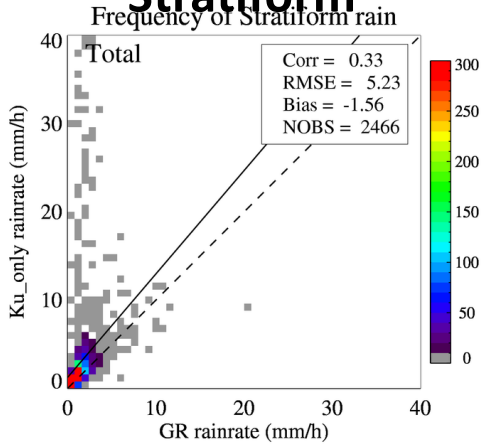


KuPR

Convective



Stratiform

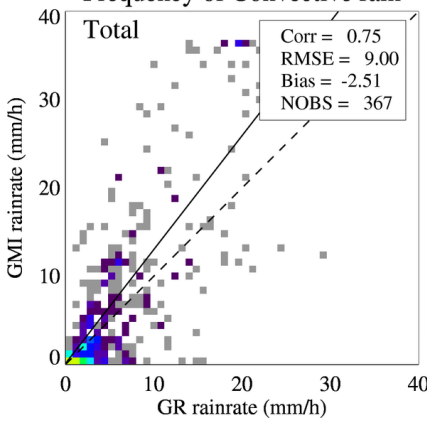


So so

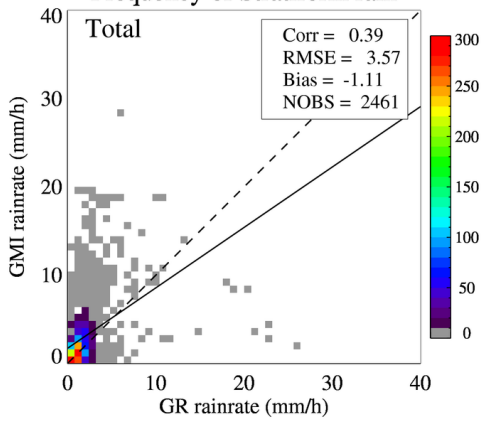
V4

Slightly WORSE

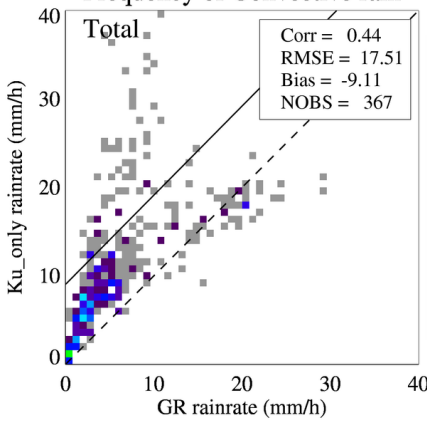
Frequency of Convective rain



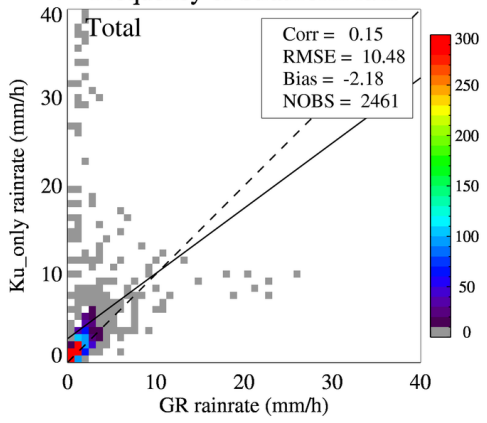
Frequency of Stratiform rain



Frequency of Convective rain



Frequency of Stratiform rain



DPR Early Evaluation of V04 Product by JAXA

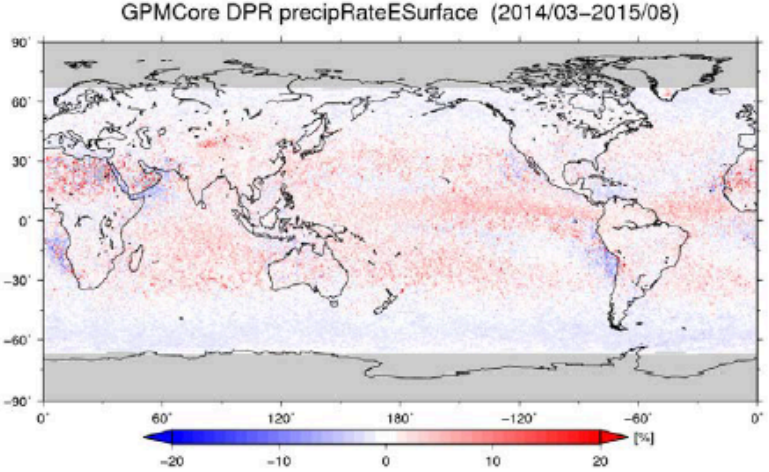
NMSC

Comparison of DPR 04 (ITE 049) with 03B

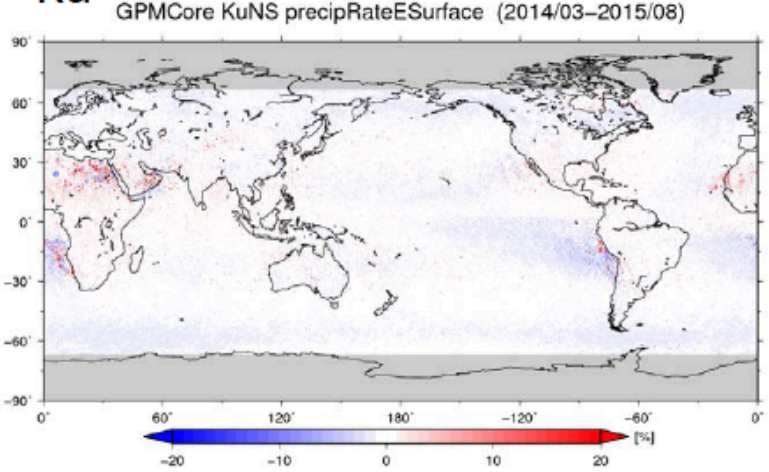
Relative change (V4-V3)/V3

(Adopted from DPR early evaluation report)

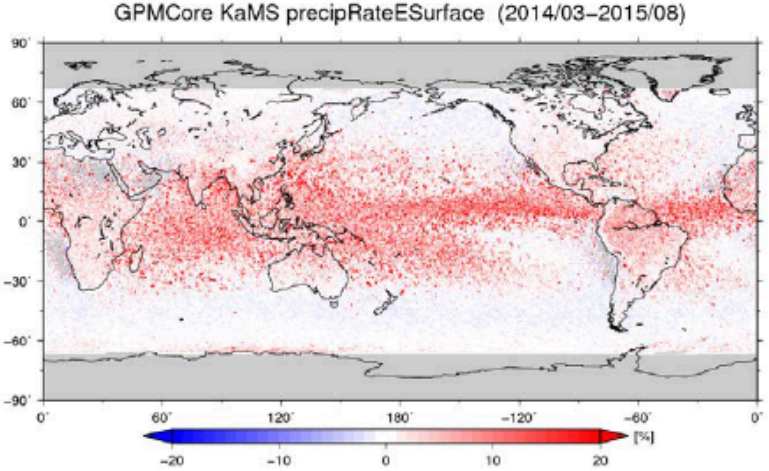
DPR



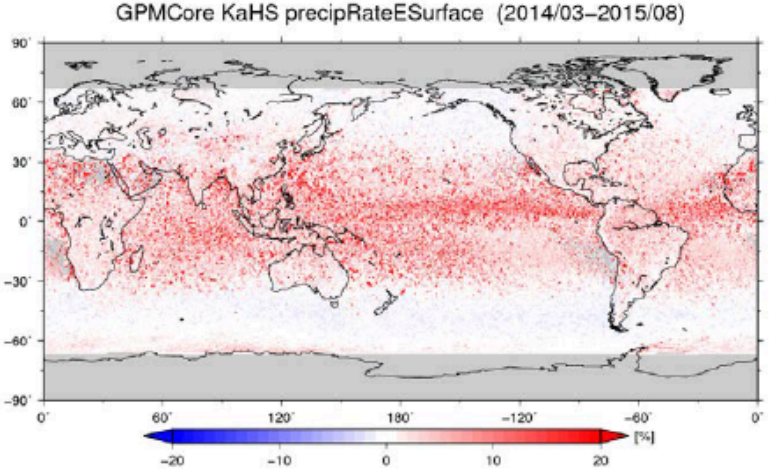
Ku



Ka(MS)



Ka(HS)



Application DFS coordinates for GPM GV

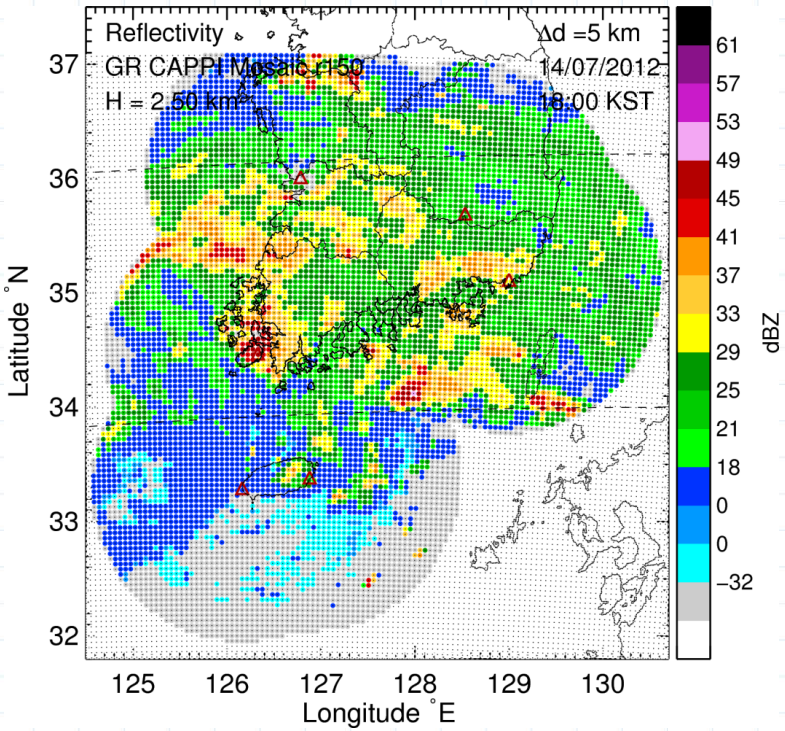
NMSC

- **Digital Forecast System (DFS)**

✓ KMA operates the DFS to provide village scale forecasts up to 2 days.

✓ DFS uses fixed grid projected on Lambert conformal conic map.

✓ Horizontal resolution can be changed from 5 km to 35 km.



[GR reflectivity projected DFS coordinates]

- **GPM DPR (KuPR, KaPR)**

✓ Level 2 Version 04A

✓ Spatial distribution : 5 km

✓ Near surface rain rate

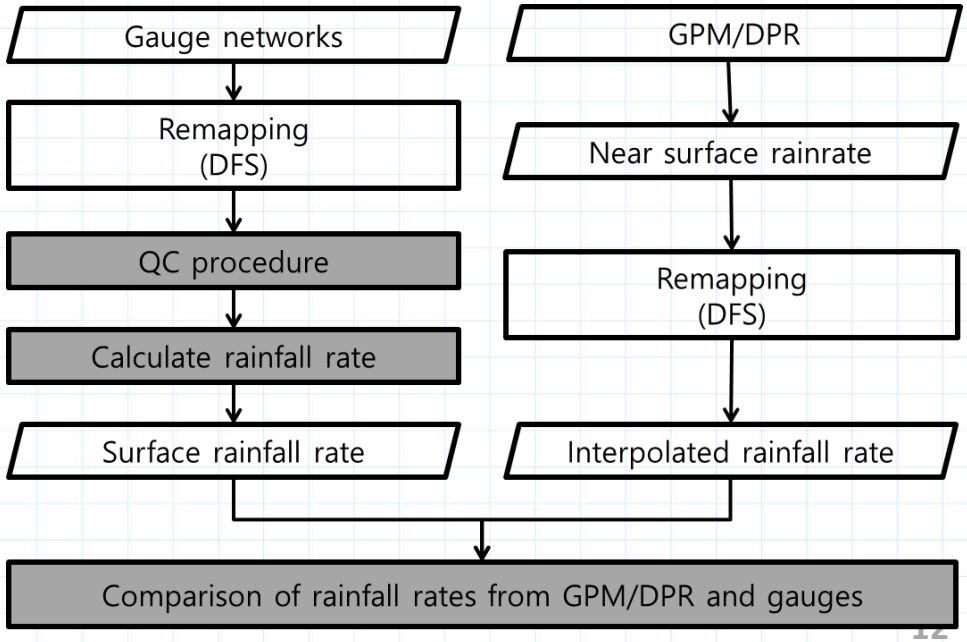
- **Gauge network (AWS)**

✓ Automatic weather stations (711 site)

✓ Spatial distribution : ~ 13 km

✓ Hourly rain rate

<Ground Validation over DFS Coordinates>



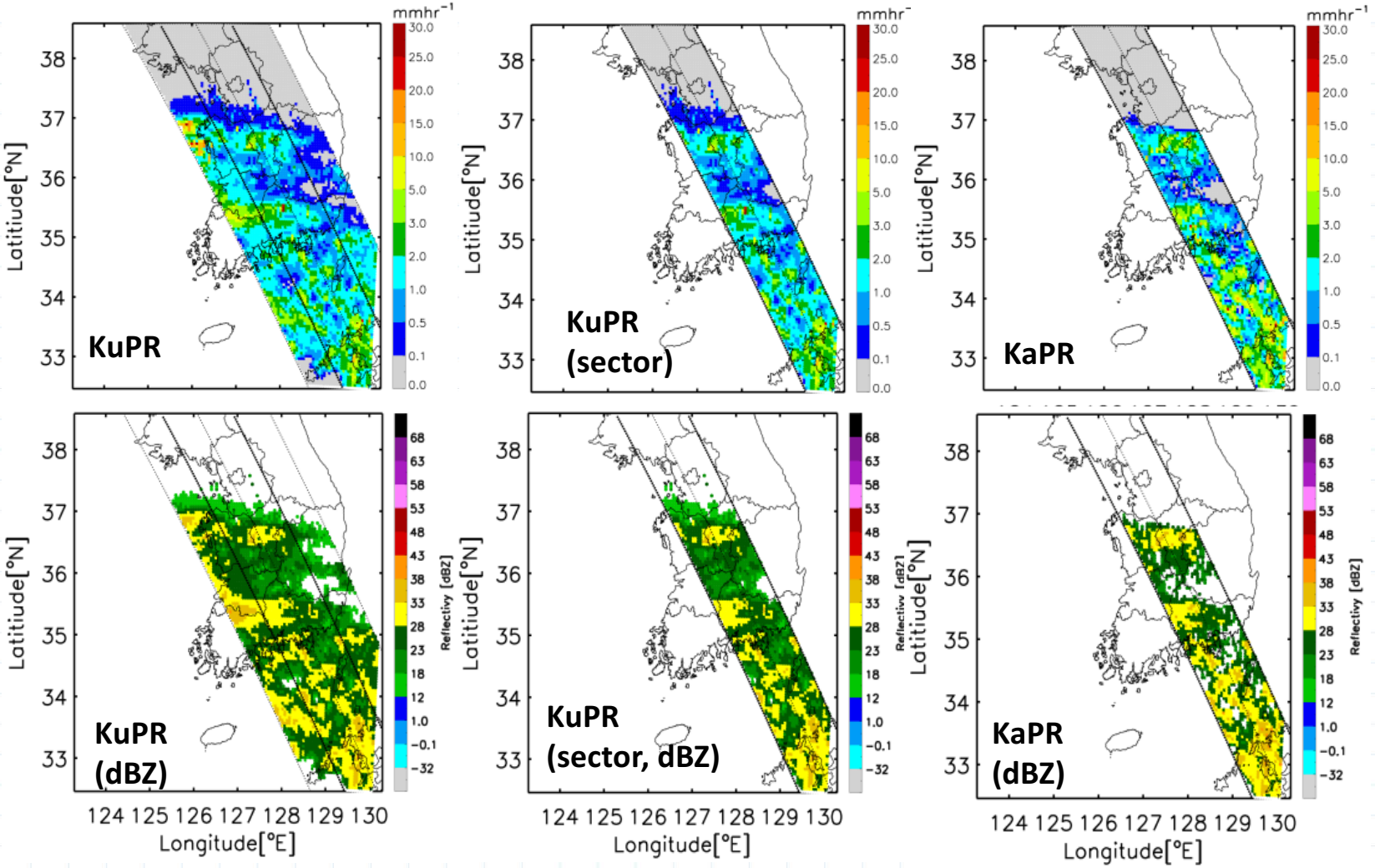
Wide spread rain system

NMSC

❖ **GPM DPR Near surface rate**
(April 6 2016 19:48 KST, DFS Coordinates)

Rain rate (mm hr^{-1})

Reflectivity (Near surface)

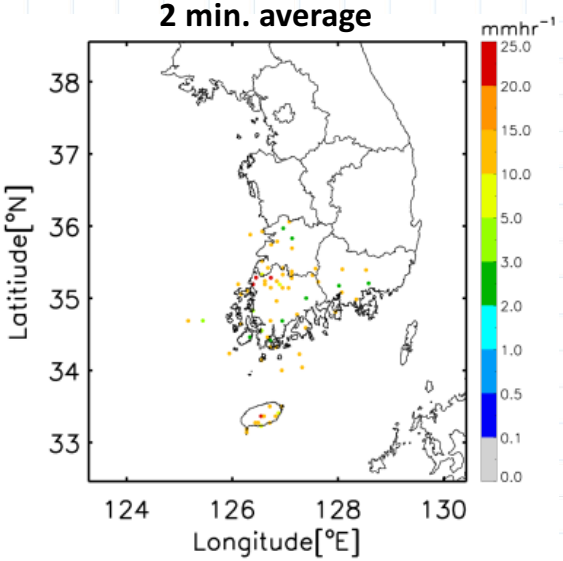


Gauge rain rate various time periods

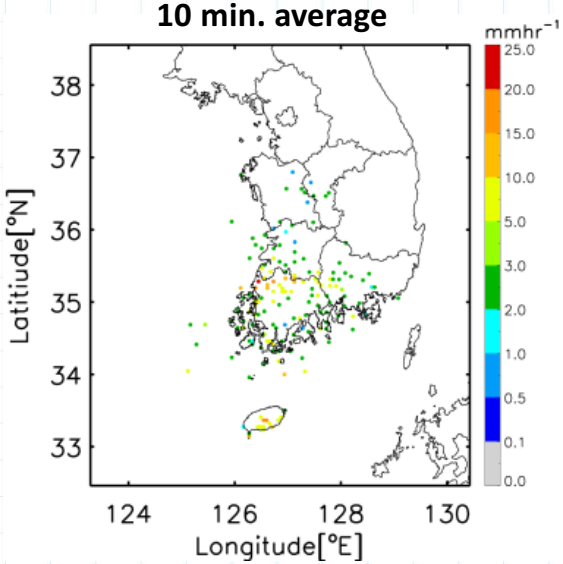
NMSC

❖ **Ground gauge rain rate (April 6 2016)**

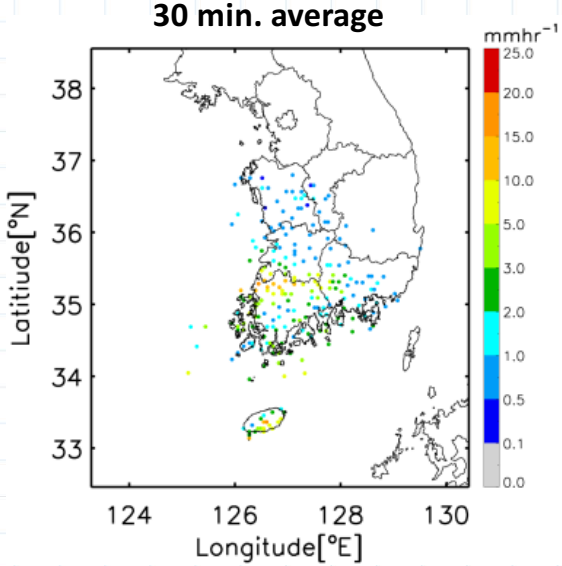
2 min. average



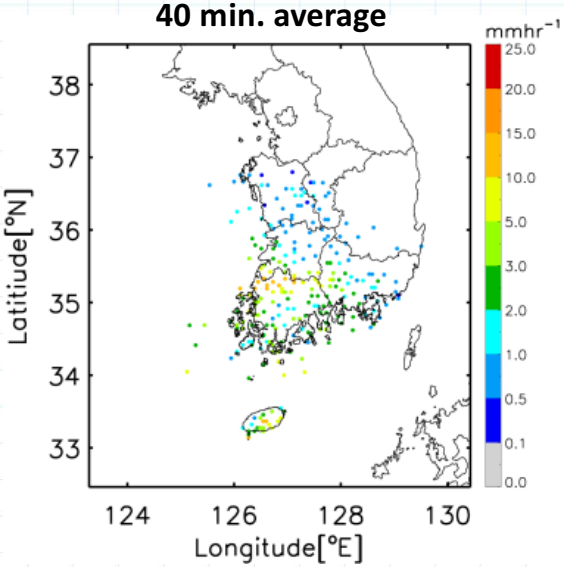
10 min. average



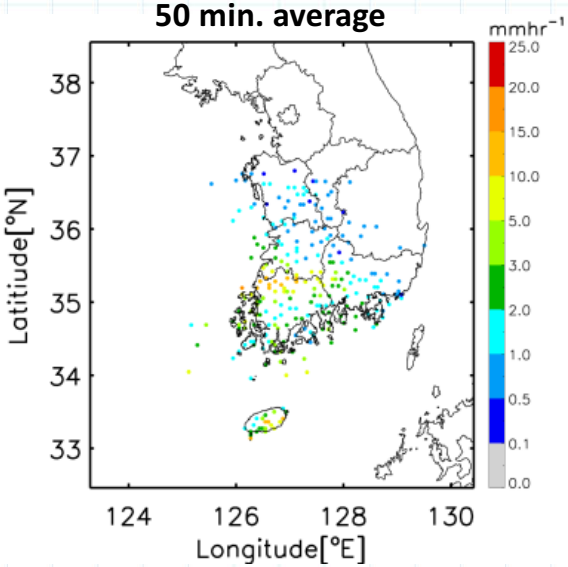
30 min. average



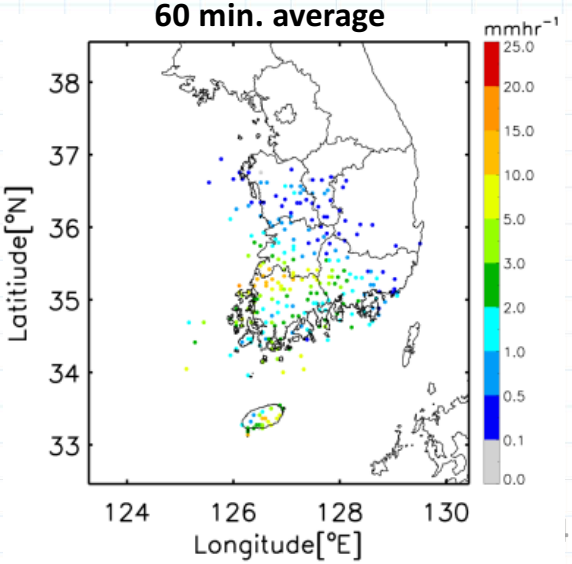
40 min. average



50 min. average



60 min. average



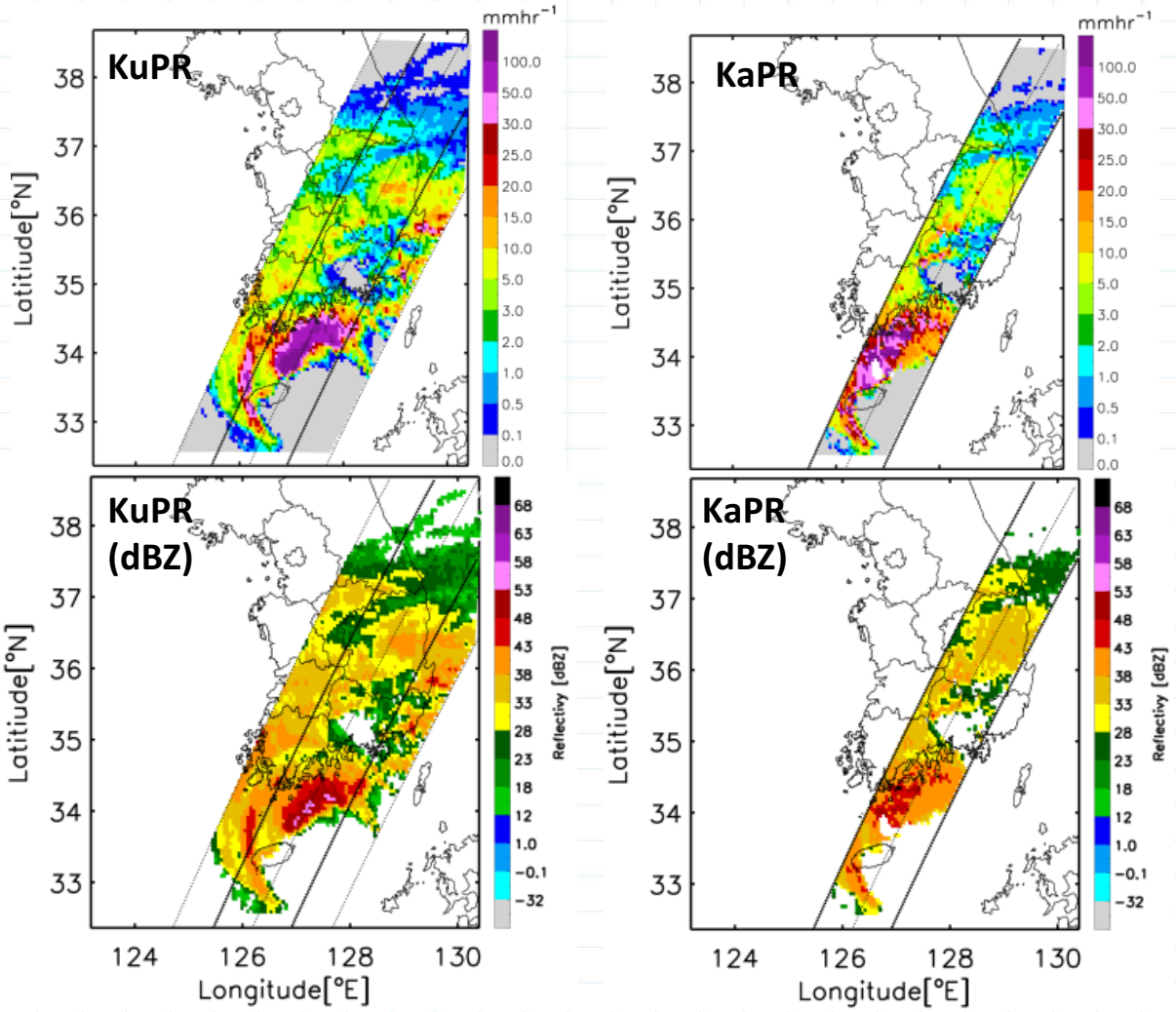
Typhoon "CHABA"

NMSC

❖ **GPM DPR Near surface rate**
(October 5 2016 05:21 KST, DFS Coordinates)

Rain rate
(mm hr^{-1})

Reflectivity
(Near surface)

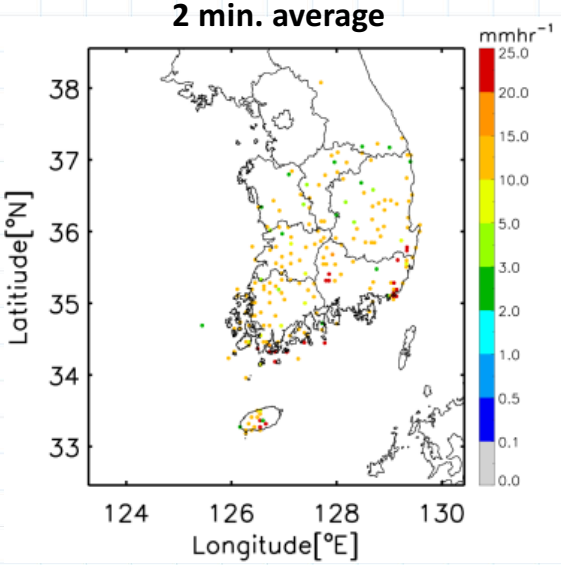


Gauge rain rate various time periods

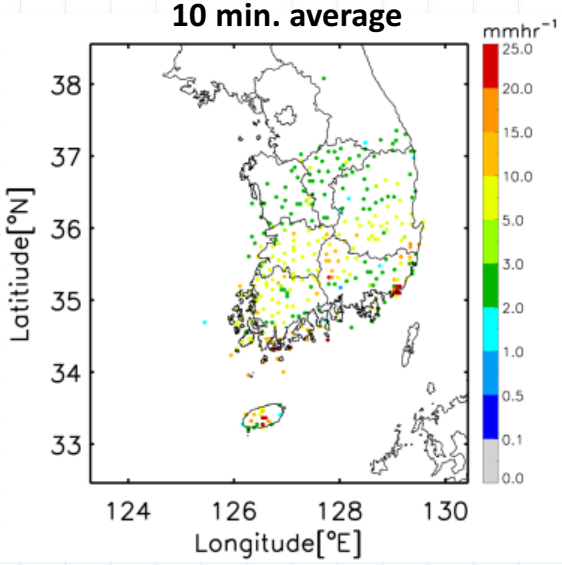
NMSC

❖ **Ground gauge rain rate (October 5 2016)**

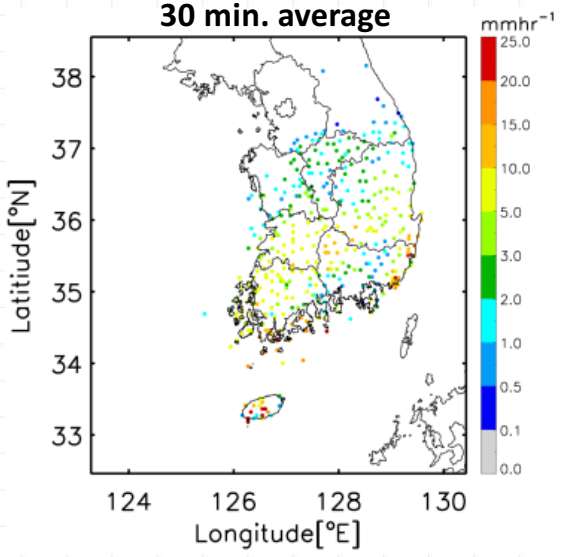
2 min. average



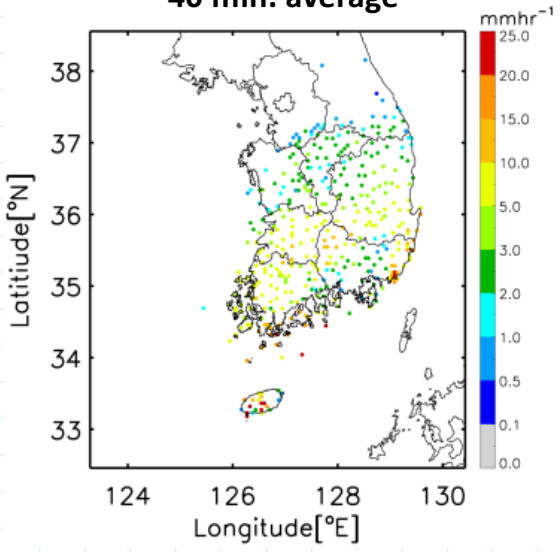
10 min. average



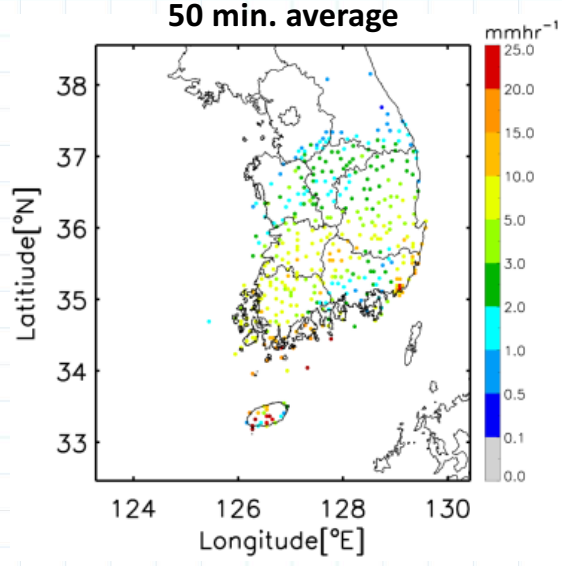
30 min. average



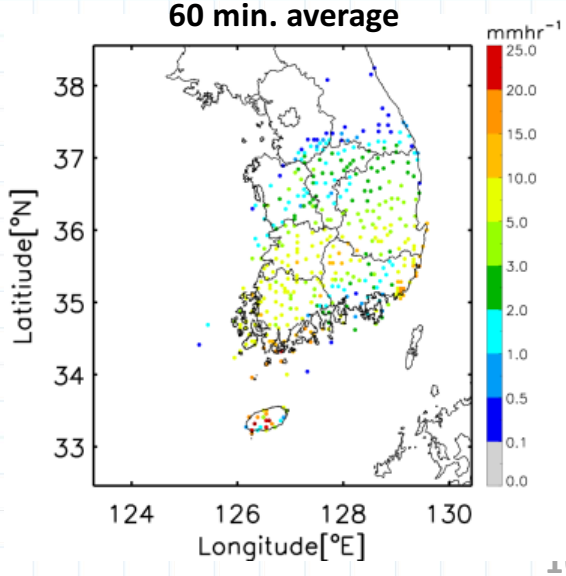
40 min. average



50 min. average



60 min. average

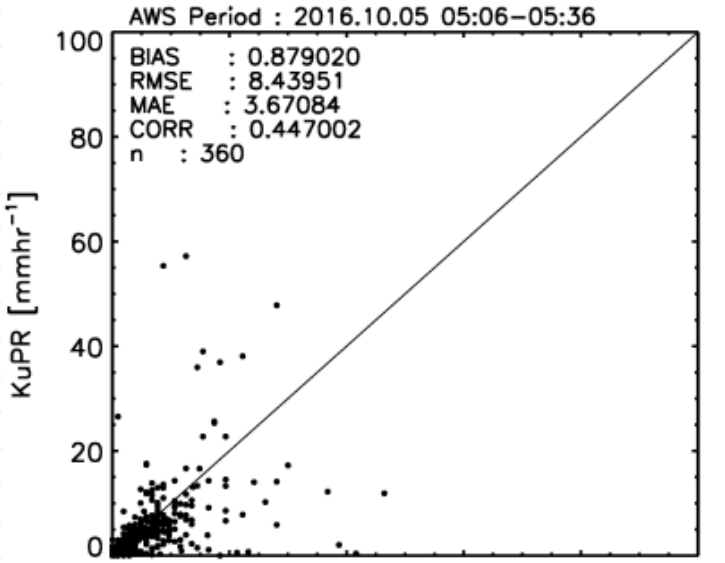


Rain rate comparison - scatter plot

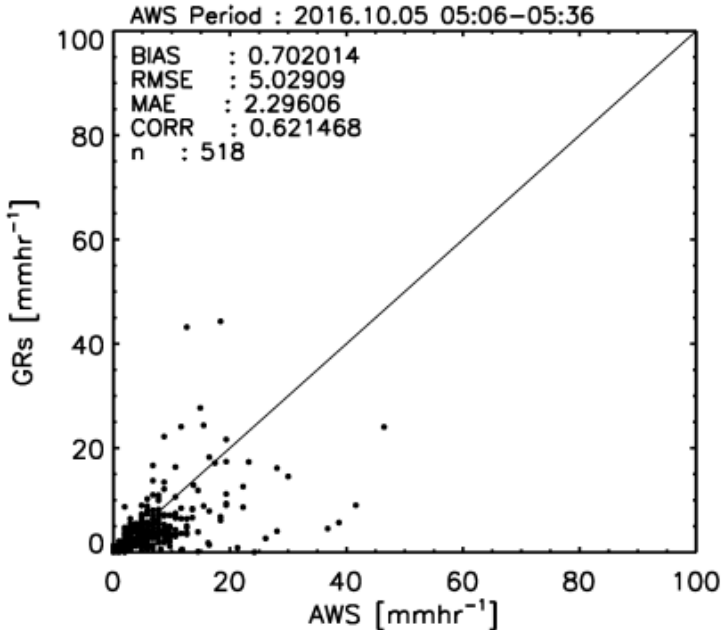
NMSC

(October 5 2016, average duration : 30 min.)

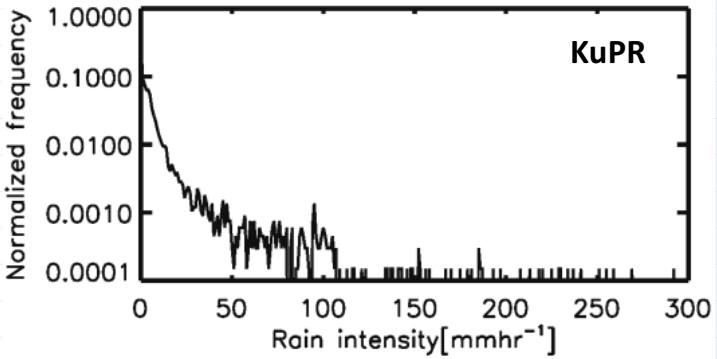
KuPR vs. Gauge

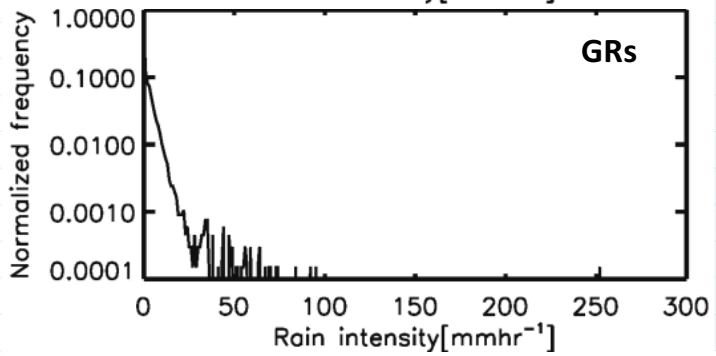


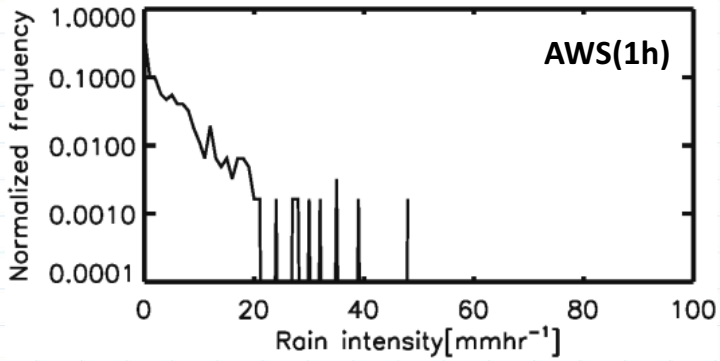
GR vs. Gauge



PDF of rain intensity



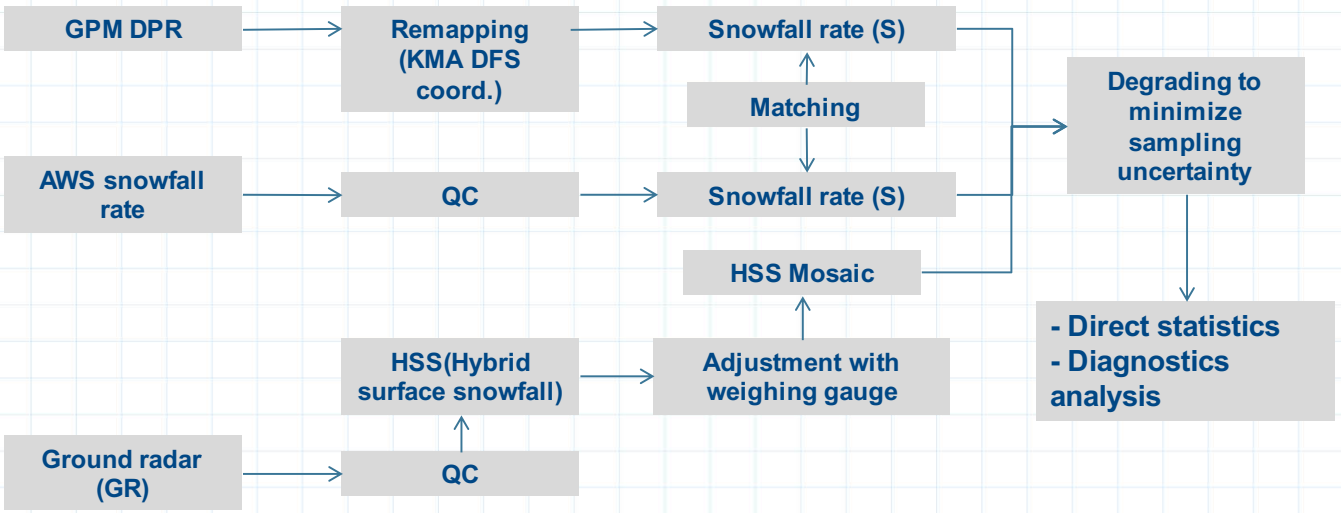




Application DFS Coord. for snowfall validation

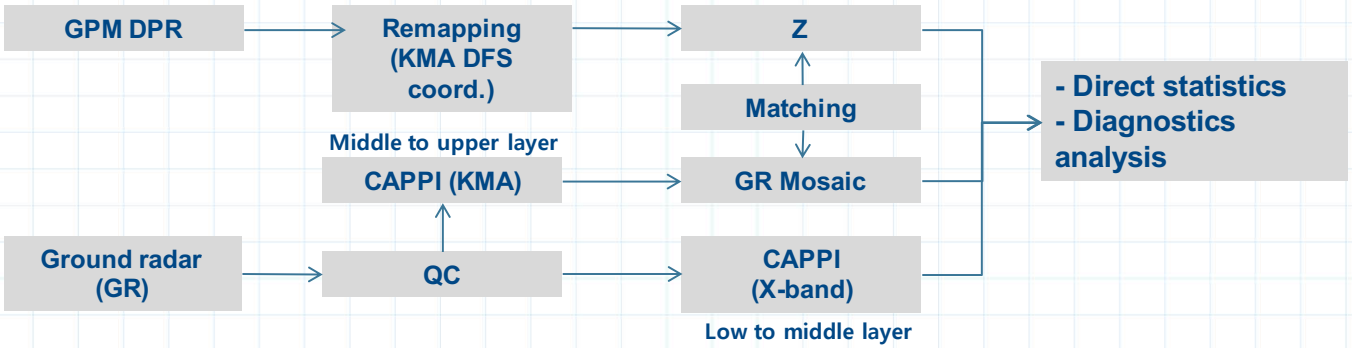
NMSC

1) Direct intercomparison of snowfall amount/rate



Issues: - Undersampling uncertainty of weighing gauge
- Accuracy of GPM DPR S and GR S
- Ability of measuring lower layer with GPM DPR and GR

2) Direct intercomparison of radar reflectivity



Issues: - Radar calibration
- Ability of measuring lower layer with GPM DPR

NMSC

PART II:

ICE-POP 2018

(International Collaborative Experiments for Pyeongchang 2018 Olympic & Paralympic winter games)

Sangwon Joo, Kwang-Deuk Ahn
Numerical Modeling Bureau
NIMS/KMA

GyuWon Lee
Kyungpook National University

Introduction of ICE-POP 2018

NMSC

- ICE-POP2018 is endorsed as an official RDP/FDP by WMO at 27 November 2015
  - Up to now 10 countries are joined the ICE-POP 2018 to advance seamless prediction from nowcasting to short-range forecast for winter weathers over complex terrains by developing intensive observation network and numerical models.

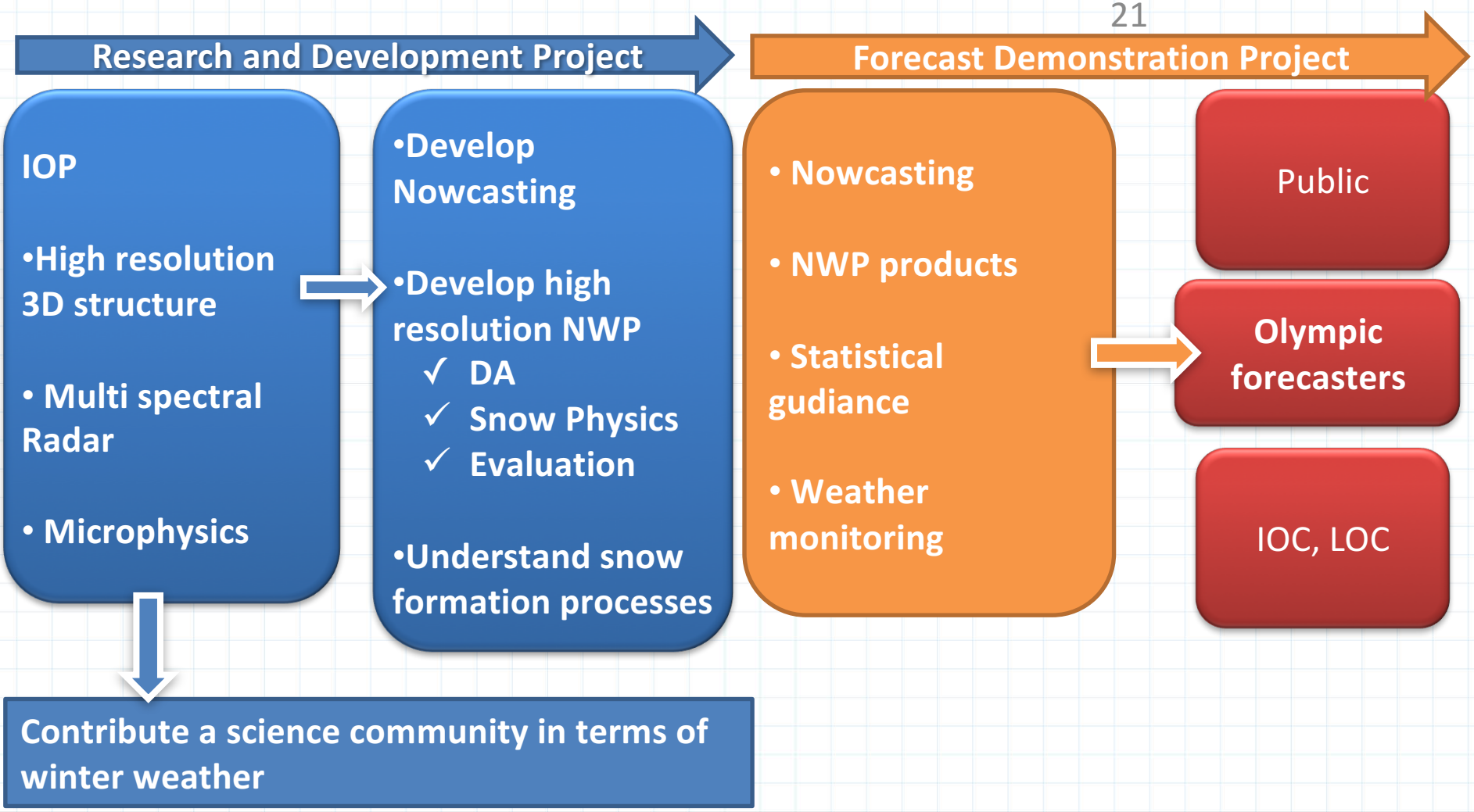
- Intensive observation network was designed to produce reliable thermodynamic and hydrophysical observation
  - **4 X-band radar, 2 cloud radars, 2 wind lidars**, and ground instruments (8 supersites) are joined IOP together with operational observation at KMA
  - Aircraft will cover oceans and upper level hydrometeor observations.
  - Sea condition will be observed by the ship and satellite.
  - The data sharing system is installed and will be available before ’17 winter for the ICE-POP participants and will be released later.

[Paricipants by country - 10]
Australia, Austria, Canada, China, Finland, Russia, Rep. Korea, Spain, Swiss, United States
[Paricipants by agency - 17]
BOM, ZAMG, EC, CMA, CAMS, FMI, Roshydromet, KMA, NIMS, UCLM, EPFL, CIRA, CSU, NASA, NCAR, NOAA, SBU

Goal & Work flow of ICE-POP 2018

NMSC

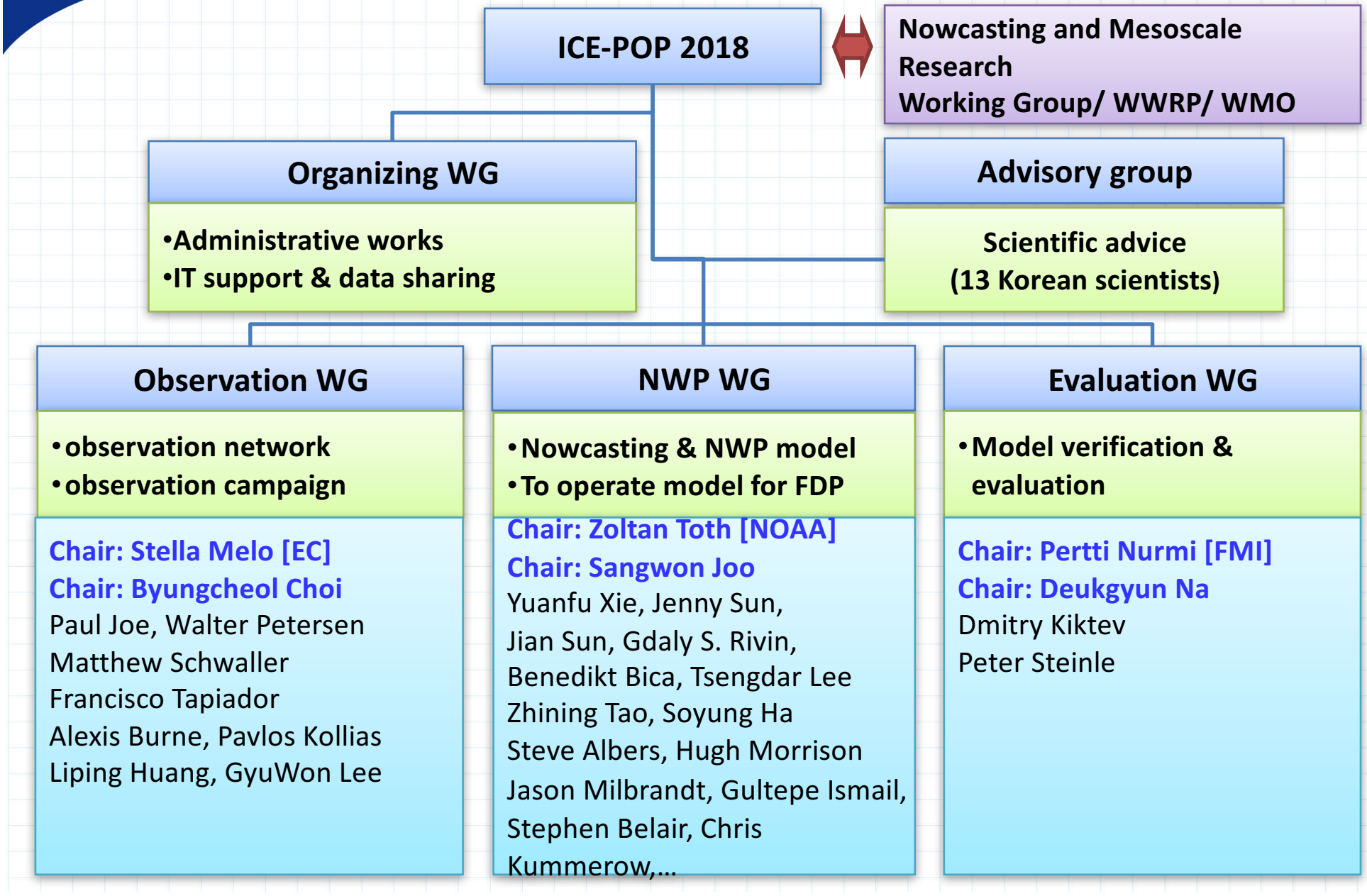
GOAL: **Advancing seamless prediction** from nowcasting to short-range forecast for winter weathers over complex terrains with intensive observation campaign



http://www.wmo.int/pages/prog/arep/wwrp/new/RDP-FDP.html

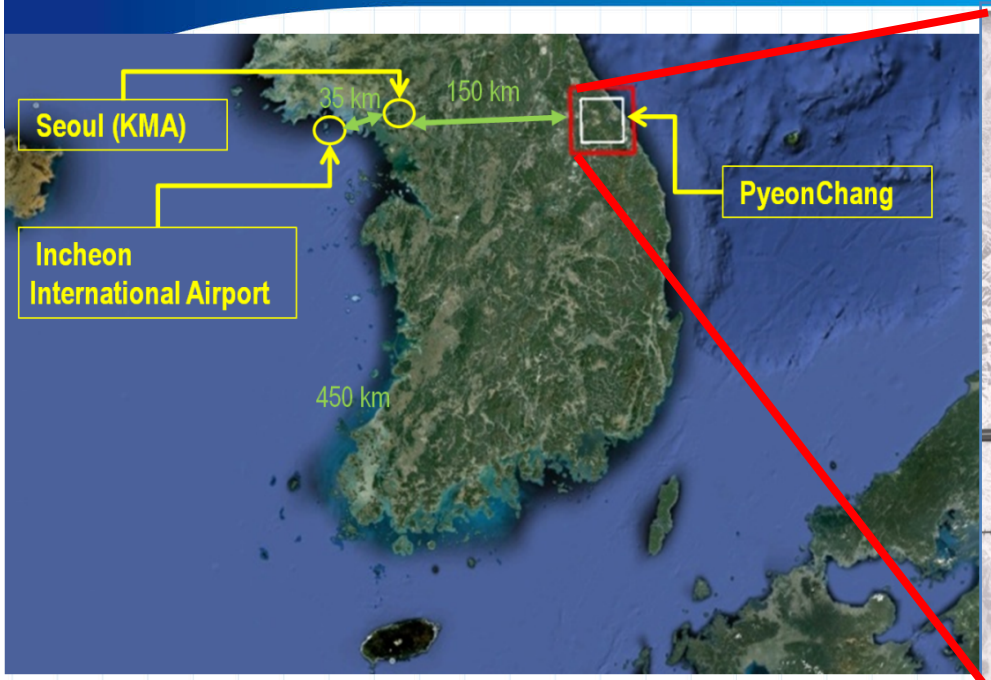
Organization of ICE-POP 2018

NMSC



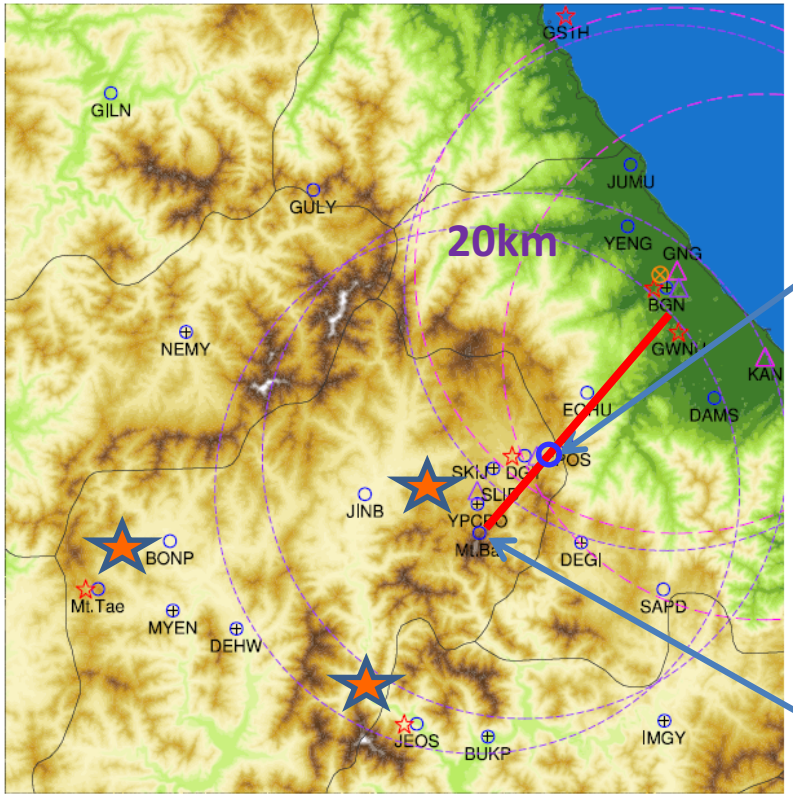
PyeongChang 2018 Olympic Area & Venues

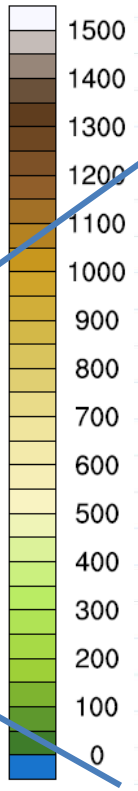
NMSC



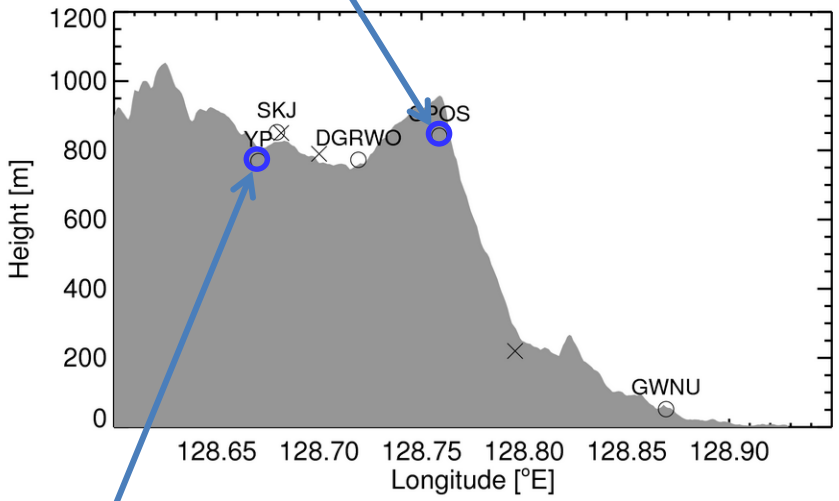
	Workforce	Services
MOC (Main Operation Centre)	Chief forecaster	Weather Briefings to MOC, IOC, NOC/NPC
WFC (Weather Forecast Centre)	Lead forecaster Venue forecasters	Venue weather forecasting Communication with media 24hours/7days operation
WIC (Weather Information Centre)	Venue communicators (All outdoor venues 1 or 2 forecasters each venue), Volunteers	Weather counselling to managers and officials related to each competition venue Weather observation

Complex Topography over the area





Cloud physics observatory



Courtesy to Gyuwon Lee

Yong Pyung

- Venues are located in a small area with complex terrain (sub km scale) and steep in the coastal region
- Heavy snow depends on the small scales flows, stability, and phase changes in a low level and conventional observation is not designed for that
- Snow weather is not captured well in the operation radar/surface observation network

Observation network over the complex terrain

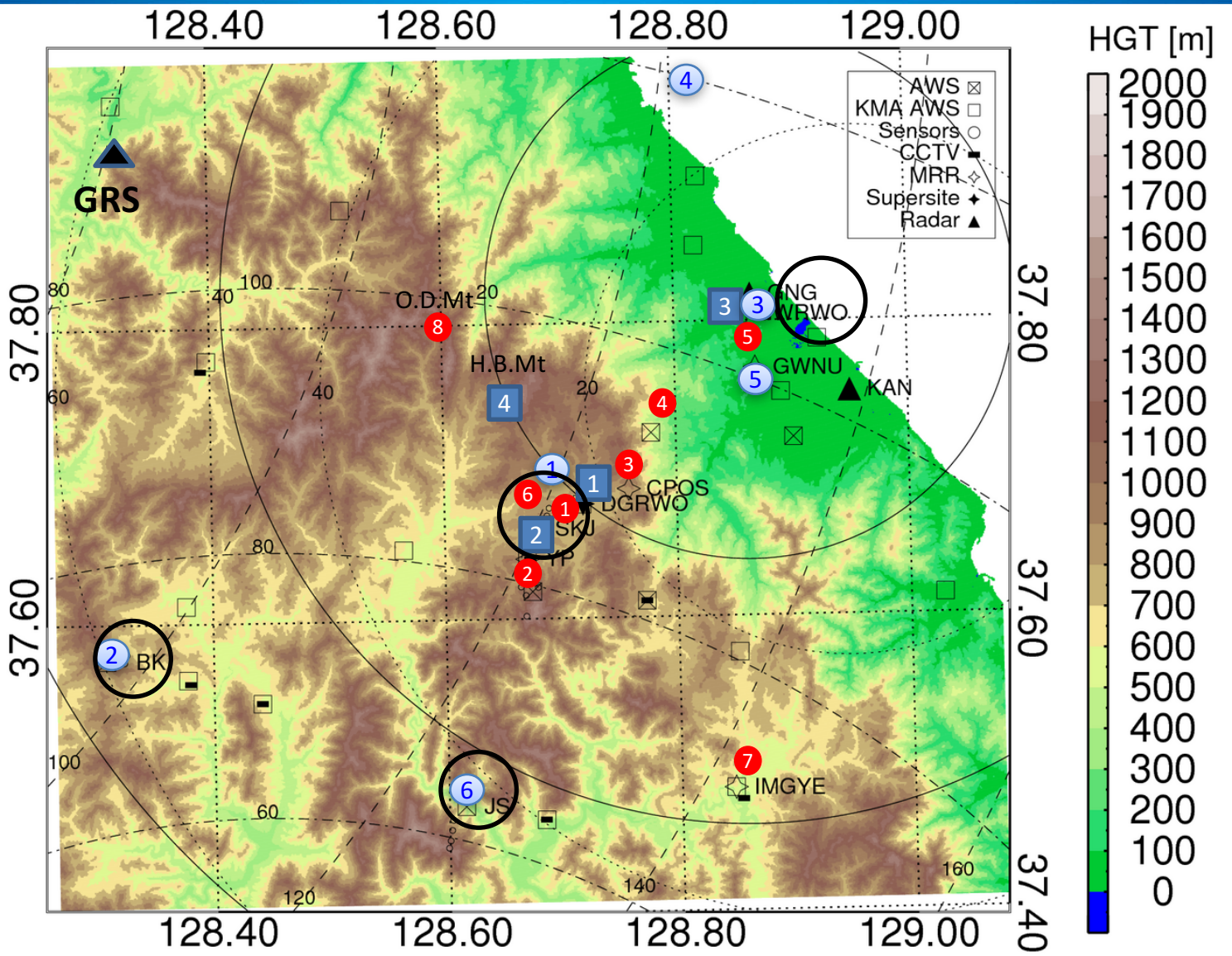
NMSC

Venue

1 Radarsite 1(DGWO)
2 Radarsite 2(APOS)
3 Radarsite 3(GWWO)
4 Radarsite 4(HBOS)

1 Sondesite 1(DGWO)
2 Sondesite 2(BKOS)
3 Sondesite 3(GWWO)
4 Sondesite 4(OBS Ship)
5 Sondesite 5(GWNU)
6 Sondesite 6(JSOS)

1 Supersite 1(MHOS)
2 Supersite 2(YPOS)
3 Supersite 3(CPOS)
4 Supersite 4(EUOS)
5 Supersite 5(GWNU)
6 Supersite 6(SJOS)
7 Supersite 7(IGOS)
8 Supersite 8(ODOS)



GNG: Gangneung radar (S-band, Operational radar/KMA)

KAN: Airforces Radar (C-band), GRS: S-band dual-pol (MOLIT)

Supersite 1 (Mayhills) instruments

NMSC

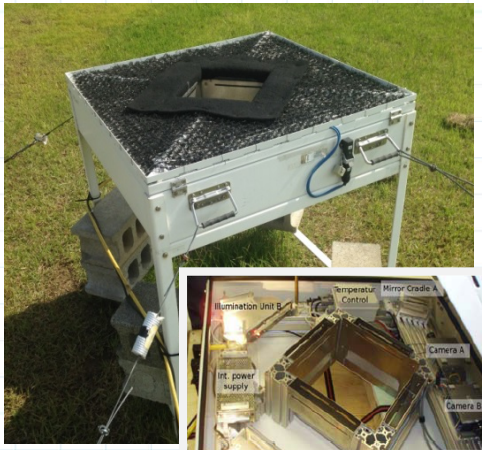
VertiX
(9.41GHz)

Cloud radar
(W-band)

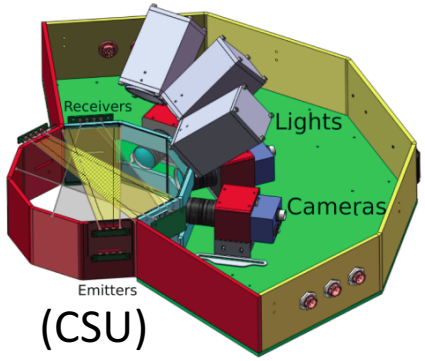
R2 Geonor

MRR(24GHz)

2DVD

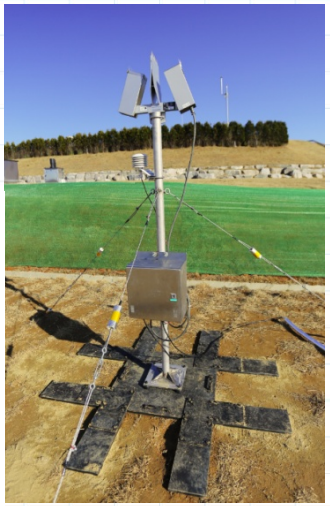


MASC



(CSU)

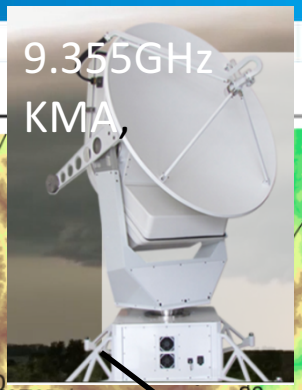
POSS



(EC)

Parsivel

RADARs in ICE-POP2018



X-Pol

D3R

Cloud radar

Scanning lidar

Supersite

RADIOSONDE

Observation Network Installation schedule

NMSC

Type	Instruments	Owner	Characteristics	Site	Installation
Precipitation Radar (PR)	R-TeamR	NCU(Taiwan)	270 deg scan, 9.6GHz	DGW	2017/01
	R-UCLM	UCLM(Spain)	Radome, 9.375GHz	APR	2017/05
	R-EPFL	EPFL(Swiss)	9.41GHz	GWW	2017/05(proposal pending)
	R-KMA	KMA	9.355GHz, Solid state Tx	HBM	2017/05
	Ku/Ka-D3R	NASA(USA)	Ku/Ka, Full scan	APR	2017/09
Cloud Radar	Ka-EPFL	EPFL(Swiss)	Vertical pointing	EHC	2017/05
	Ka-SUNY	SBU(USA)	Ka scanning /radiometer		Under consideration
	W-SUNY	SBU(USA)	W-band	MHS	2017/09
Doppler Lidar	Lidar-EC	EC(Canada)	Full scan	DGW	2016-09
	Lidar-EC	EC	Full scan	Mobile (Upstram)	2016-09
Wind Profiler	W-KMA	KMA	UHF	GWW	Operation
VertiX	VertiX-KNU	KNU(Korea)	Vertical pointing 9.41GHz	MHS	2016-10
2DVD	2DVD-KNU	KNU	V3	MHS	2016-10
	2DVD-NCU	NCU	V1	EHC	Under consideration
MASC	MASC-CSU	CSU(USA)		MHS	2016/11
	MASC-EPFL	EPFL		EHC	2017/05(proposal pending)
	MASC-EC	EC		YPO	Under consideration

Type	Instrument	Owner	Characteristics	Site	Installation
MRR	MRR-KNU	KNU		MHS	Operation(will be moved)
	MRR-NIMS1	NIMS/KMA		YPO	Operation
	MRR-NIMS2	NIMS		CPO	Operation
	MRR-NIMS3	NIMS		SJO	Operation
	MRR-NIMS4	NIMS		IGD	Operation
	MRR-NIMS5	NIMS		ODO	Operation
	MRR-EC	EC		DGW	Not Decided
	MRR-NASA	NASA	1~2 units	Not decided	Not Decided
	MRR-CSU	CSU	2 units	GWU	2017/??
Parsivel	Par-KNU	KNU		MHS	Operation(will be moved)
	Par-NIMS1	NIMS		YPO	Operation
	Par-NIMS2	NIMS		CPO	Operation
	Par-NIMS3	NIMS		SJO	Operation
	Par-NIMS4	NIMS		IGD	Operation
	Par-NIMS5	NIMS		ODO	Operation
	Par-EC	EC			Not Decided
	Par-UCLM	UCLM	16 units	DGW	2016-09
	Par-NASA	NASA		Not decided	Not Decided
	Par-CSU	CCU	V1, V2, 2 units	GWU	2017/??
PIP	PIP-NASA	NASA	1+ units	MHS	Not Decided
POSS	POSS-KNU	KNU	2 units	MHS	Operation
	POSS-EC	EC	5 units	YPO	2017/08
DFIR	DFIR	KNU		MHS	Not Decided
Gauge	Pluvio-NASA	NASA	3(EC)	MHS	Not Decided
	Geonor-KNU	KNU			Not Decided
	Pluvio-NIMS1	NIMS		CPO	Operation
VIS	Vis-EC	EC	1	CPO	Not Decided
	Vis-NIMS	NIMS		CPO	Operation
	Vis-KMA1	KMA		DGW	Operation
	Vis-KMA2	KMA		GWW	Operation

Observation Network Installation schedule

NMSC

Type	Instrument	Owner	Characteristics	Site	Installation
Radiometer	MWR-NIMS	NIMS/KMA		CPO	Not decided
	MWR-KMA	KMA		GWW	Not decided
Ceilometer	CLM-NIMS1	NIMS/KMA		CPO	Current
	CLM-NIMS2	NIMS/KMA		SJO	Current
	CLM-NIMS3	NIMS/KMA		GWW	Current
	CLM-KMA1	KMA		DGW	Current
	CLM-KMA2	KMA		GWW	Current
3D Anemometer	CSAT-NIMS1	NIMS/KMA		CPO	Current
	CSAT-NIMS2	NIMS/KMA		YPO	Current
Particle counter /Measure	HCT-NIMS	NIMS/KMA	7~830㎚	CPO	Current
	OPC-NIMS	NIMS/KMA	0.25~32㎛	CPO	Current
	FM120-NIMS	NIMS/KMA	2~50㎛	CPO	Current
	MPS-NIMS	NIMS/KMA	50㎛~3.1㎜	CPO	Current
Snow depth	BYL-NIMS	NIMS/KMA	Weighting	CPO	Current
	LSND-NIMS1	NIMS/KMA	Laser	YPO	Current
	LSND-NIMS2	NIMS/KMA	Laser	ODO	Current
	LSND-NIMS3	NIMS/KMA	Laser	IGD	Current
All Sky Camera	ACOS-NIMS	NIMS/KMA		CPO	Current
Ground GNSS	GNS-NIMS1	NIMS/KMA	Ground GPS	SJO	Current
ORG	ORG-NIMS1	NIMS/KMA	Optical Rain Gauge	SJO	Current
Wind Profiler	WPR-KMA	KMA		DGW	Current
Integrated sensor		KMA	22 units	Venue	Current
Road WX		KMA	3 units	Road	Current
CCTV		KMA	10 units		Current
Aircraft	ACR-NIMS	NIMS			
Ship	OSHI-NIMS	NIMS			

Implementation Plan

NMSC

Observation

RAOB
Ship
Mobil Vehicle

Wind lidar
Parsivel

X pol band
Aircraft

X band R
Cloud R
Satellite
(Geocloud,flux
Hourly SST)

D3R
Ka/Ku radar

Final Report

&

Paper in Special Volume

Model

KMA NWP
+Guidiace
VDAPS

CAN
FINECAST
INCA
VDAPS

GEM-LAM
INTW
COSMO
NuWRF
MPAS
GRAPES
UM(Reading)

Real time Service

Workshop

Preliminary evaluation & progress report

Progress report , Operation Check up

Nov. 8~10 2016

Scientific Challenges

NMSC

- **To coordinate comparison study of sub km scale NWP** models in mesoscale winter weather condition over complex terrain with dense observation networks **to understand predictability of high resolution NWP models**
  - GEM-LAM(0.2K), COSMO(0.17K), UM(0.2K), MPAS(0.2K), UM Downscaling(0.1K) is to join the comparison and wait a contribution from GRAPES.
- **To evaluate** the benefit of different **nowcasting approaches to develop seamless prediction** from nowcasting to short-range NWP prediction
  - MAPLE, INCA, CAN, FINECAST, INTW will be operated to support forecasters
  - Analysis, prediction and blending method will be evaluated to understand the optimal way to make a seamless prediction with nowcasting and NWP prediction
- **To advance physical processes** of snow microphysics, surface processes over land and ocean, and fog/low level cloud processes
  - The Predicted Particle Properties(P3) scheme will be calibrated with the observation and implemented to some of the RDP models
  - Fog/low level cloud physics in NWP
  - Land surface model and interaction with atmosphere will be compared
- To create valuable, reliable and accessible thermodynamical and hydrometeorological **Intensive observation data sets** for winter weather over a complex terrain through IOP
  - Ground validation of satellite (i.e. ADM Aeolus GPM snow retrieval)
- To understand microphysical processes over complex terrain such as snow size, shape distribution, vertical structure with **multi-frequency radar and various microphysical observations** (i.e. Radar site 1 and supersites) with better quality control

Summary

NMSC

- **Direct Validation using VN over Korea has been performed including other agency instruments.**
  - Although there is not enough rain event recent years over Korea, it seems to be good correlation in reflectivity between GR and DPR.
  - The integrated radar network over Korea is supposed to be enough to decrease the validation radius and might be applied to Physical Validation with dual pol radars.
  - Algorithm improvement is not significant over Korea based on VN statistics.
  - DFS coord. over Korea is used to validate GPM using Gauge network, and DFS coord. can be validation frame over Korea like MRMS over US.

- **In the ICE-POP 2018, Intensive observation network is designed to produce reliable thermodynamic and hydrophysical observation.**
  - Advancing seamless prediction from nowcasting to short-range forecast for winter weathers over complex terrains with intensive observation campaign.
  - Up to now 10 countries are joined the ICE-POP 2018 to advance seamless prediction.
  - 4 X-band radar, 2 cloud radars, 2 wind lidars, and ground instruments (8 supersites) are joined IOP together with operational observation at KMA.


THANK YOU!