JAXA PMM RA-7 PI Meeting, January 15 ~ 17, 2014, Tokyo, Japan

Investigation of Precipitation Mechanism and Processes over East Asia

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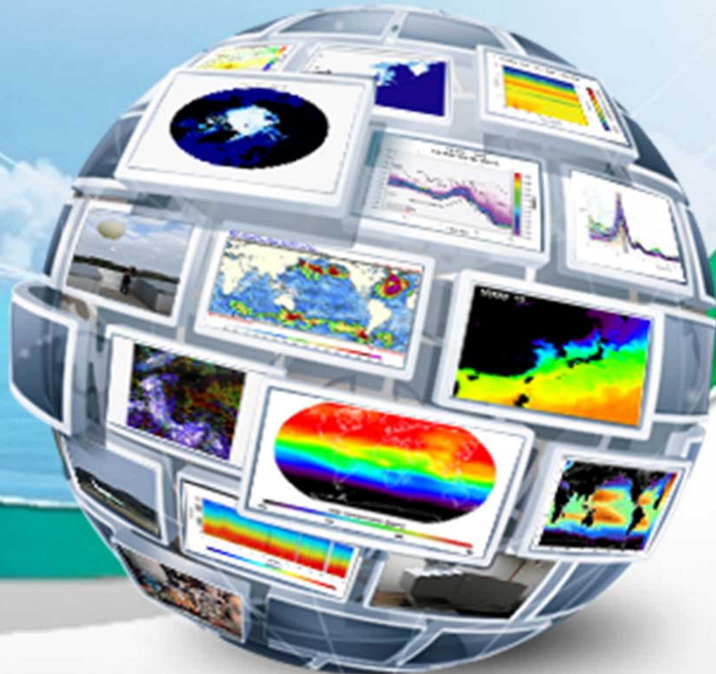

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Overview

❖ Purpose of this research

- To better understand the precipitation characteristics, and finally to help producing high quality of satellite based precipitation data over E. Asia in the framework of GPM GV

❖ Recent studies on precipitation over the E. Asia region

- Rainfall Characteristics in East Asia as Observed by TMI/GMI and PR/DPR
- Analysis of Climatic Characteristics of Precipitation
- Precipitation Mechanism based on ground-based instrumentations

❖ Collaboration with JAXA on GPM GV

- The 6th KMA-JAXA collaboration meeting was held in Oct. 2, 2013 since the 1st meeting has been in 2010 at Seoul, Korea
- Korea and Japan are in very similar environment, especially for precipitation mechanism. In this regard, it is good motivation to enhance knowledge by working together
- KMA came to an agreement with JAXA for the participation of DPR quick evaluation GV over the Korean peninsula

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Rainfall Characteristics in East Asia as Observed by TMI/GMI and PR/DPR

by Eun-Kyoung Seo (Kongju National University)

Background & Necessity of this study

- GPM provides excellent opportunities of high resolution in space and time to Korea from 2014.
- Korean peninsula and its surroundings have unique geographical and geophysical environments such as peninsula, surrounding oceans, strong baroclinic region, mid-latitude, monsoon rain in summer and so on. As expected, its precipitation characteristics are quite different from those of subtropical East Asia, and tropical East Asia. (e.g., Seo 2011; Sohn 2012).
- Those characteristics are clearly reflected in TB(85GHz) – rain rate relations (Seo 2009; Ryu et al. 2012).
- Even though many efforts have been made in the GPROF rain algorithm, it still shows large systematic bias compared to PR rain (e.g. Seo et al. 2007; Seo et al. 2014)
- Hence, the GPM rain retrieval is very challenging in the region.

Objectives of this study

- **To examine "physical and statistical rainfall characteristics in East Asia"** as observed, in particular, by TMI/GMI and PR/DPR, and furthermore to provide a remarkable guidance for improving passive microwave rain retrieval algorithms in this region.

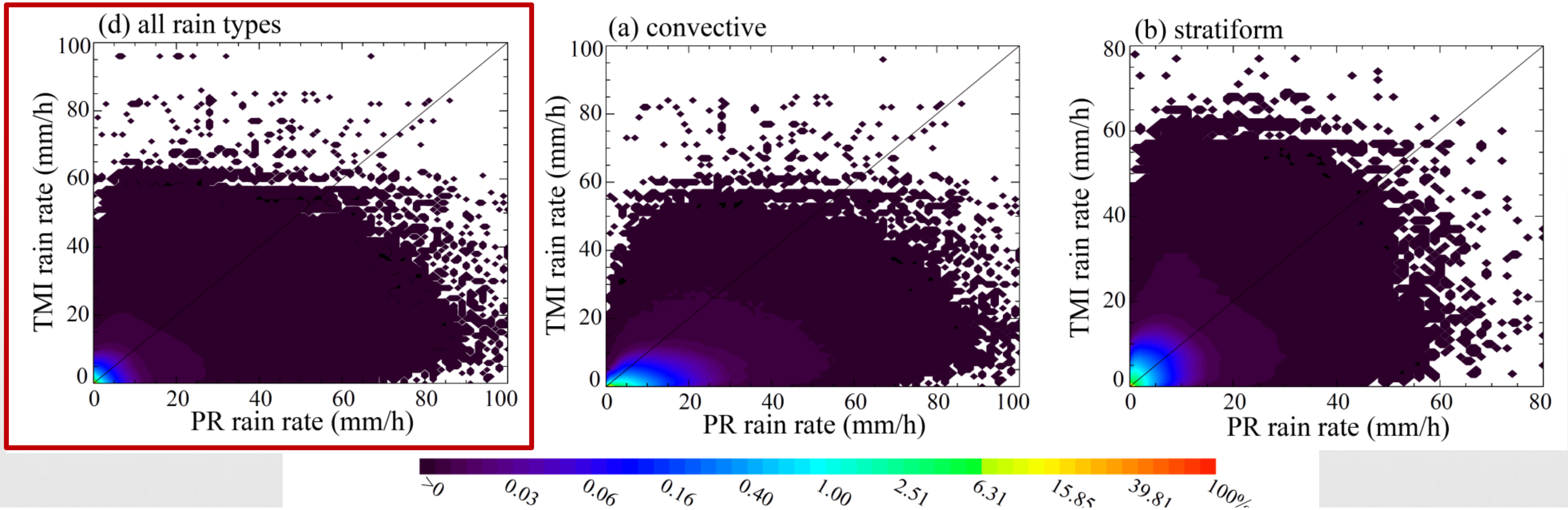
Rainfall Characteristics in East Asia as Observed by TMI/GMI and PR/DPR

Data used in this study

- Datasets used in this study are the version 7 products of TMI- and PR-derived rain rates over oceanic regions for JJAs (June, July, and August) for northern hemisphere and DJFs (December, January, February) for southern hemisphere from 1997 December to 2013 .
- We collected instantaneous rain rates for the exact collocations between TMI and PR measurements, collocated on the same horizontal scale and for the entire period of TRMM observations.

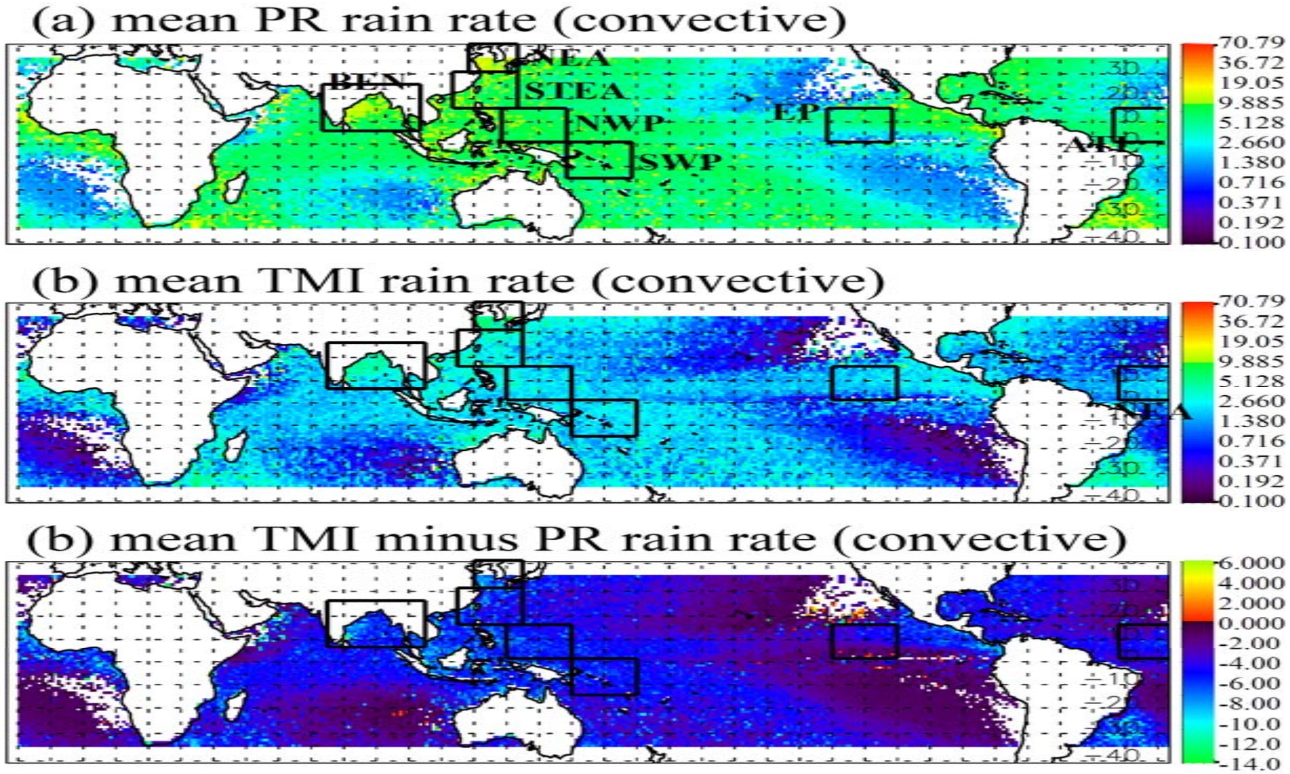
Results

- The comparison of V7 rain retrievals from TMI and PR shows a very close correspondence between the two estimates when performing the statistics comparison globally and over all rain types.



Rainfall Characteristics in East Asia as Observed by TMI/GMI and PR/DPR

- A detailed look by rain type and geographical region reveals that many discrepancies still exist.
- **The disagreement predominately occurs for convective rain type and over the regions where clouds are mainly convective in nature**.
- In particular, the largest negative differences are found **in the wet regions** of ITCZ, monsoon and extratropical cyclone paths.
- Overall, the convective TMI rain has a clear tendency to be underestimated compared to PR rain in the most of the wet regions of the globe.



Statistics of global TMI and PR rain rates as a function of rain types

	Convective	Stratiform	Others	Residual	All types
Frequency by pixel number [%]	3.20%	21.20%	48.76%	26.94	100%
Fraction by total rain [%]	22.30%	52.64%	26.35%	0.01	100%
Mean TMI rainrate [mm/h]	2.24	2.54	0.48	0.42	0.96
Mean PR rainrate [mm/h]	6.81	2.43	0.53	0.00	0.98
TMI –PR [mm/h] (TMI-PR)/(0.5*(TMI+PR)) [%]	-4.57 -101.00%	0.11 4.43%	-0.05 -9.90%	0.42 200.00%	-0.02 -2.06%

Analysis of Climatic Characteristics of Precipitation

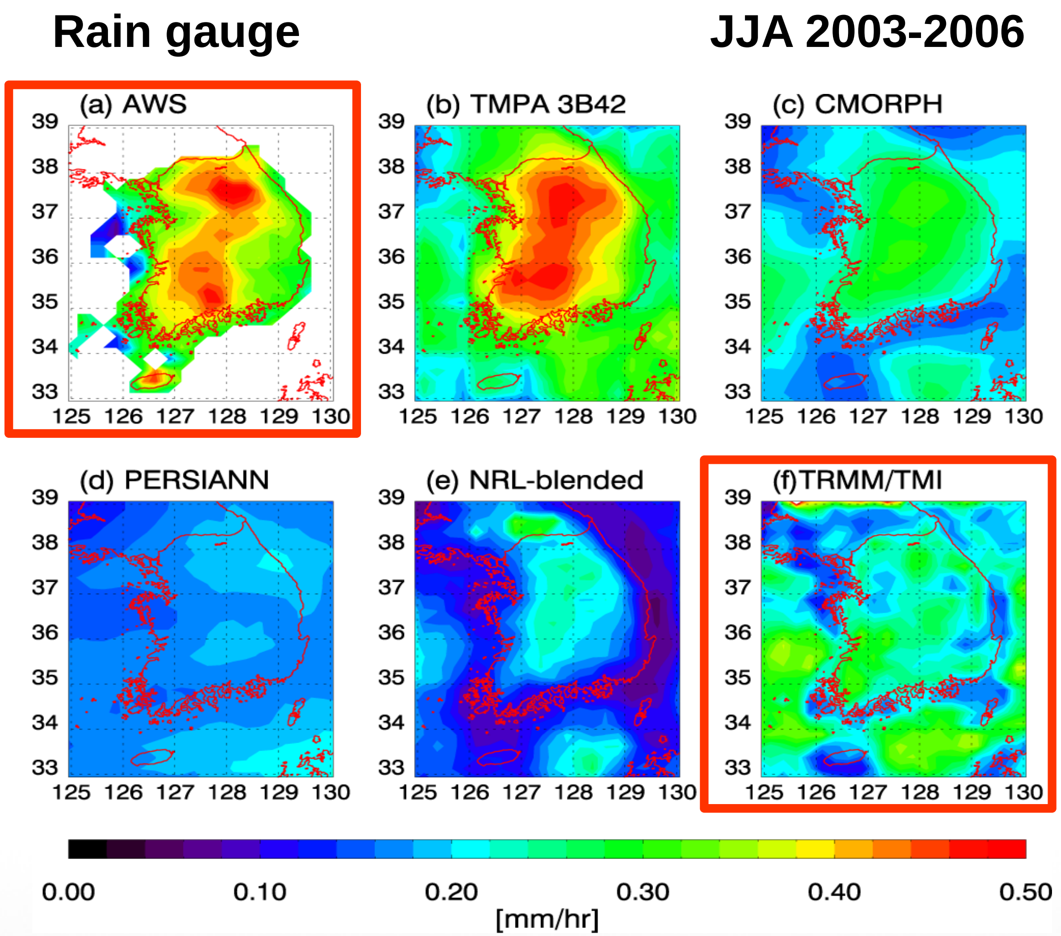
by Byung-Ju Sohn (Seoul National University)

Background

- Severe underestimation of satellite-based rain retrieval over Korea (Sohn et al. 2010)
- TMI land algorithm uses only the TB depression by scattering at 85 GHz.
- The relationship between TB85 and surface rain rate developed for US seems not to work well over Korea.

Objectives

- **To explain a fundamental cause in the problem of satellite-based rain estimation over Korea from regionally different rain characteristics**
- To understand the associated mechanism from the large-scale atmospheric environment



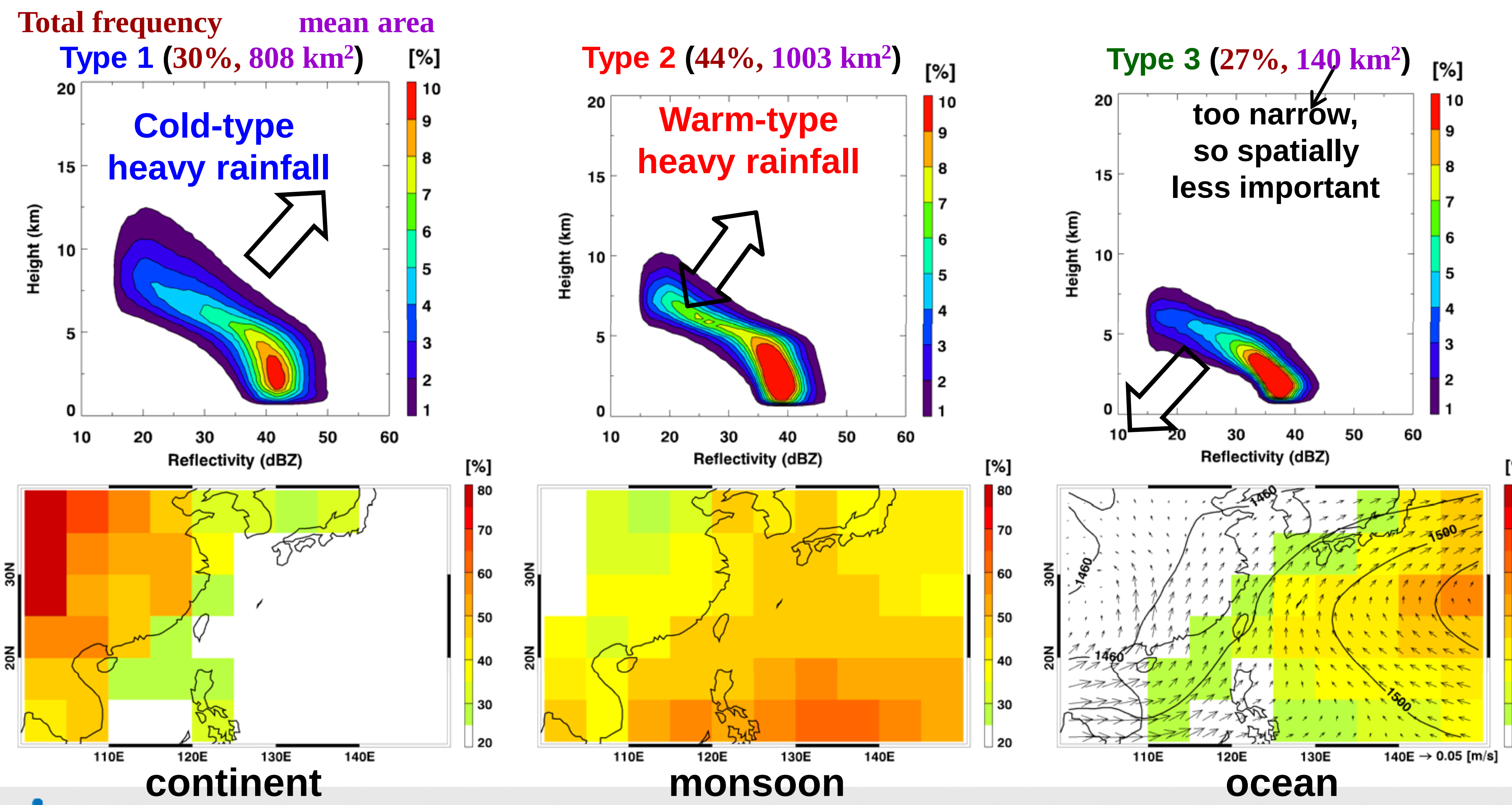
(f) Microwave based rain product (TMI) is severely underestimated over Korea

(c-e) Other IR or IR-MW blended rainfall products may also be underestimated owing to the calibration of IR-based rain estimates against the microwave-based estimates.

(b) TMPA is scaled against the surface rain gauge

Heavy Rainfall (> 10 mm/h) Type Classification

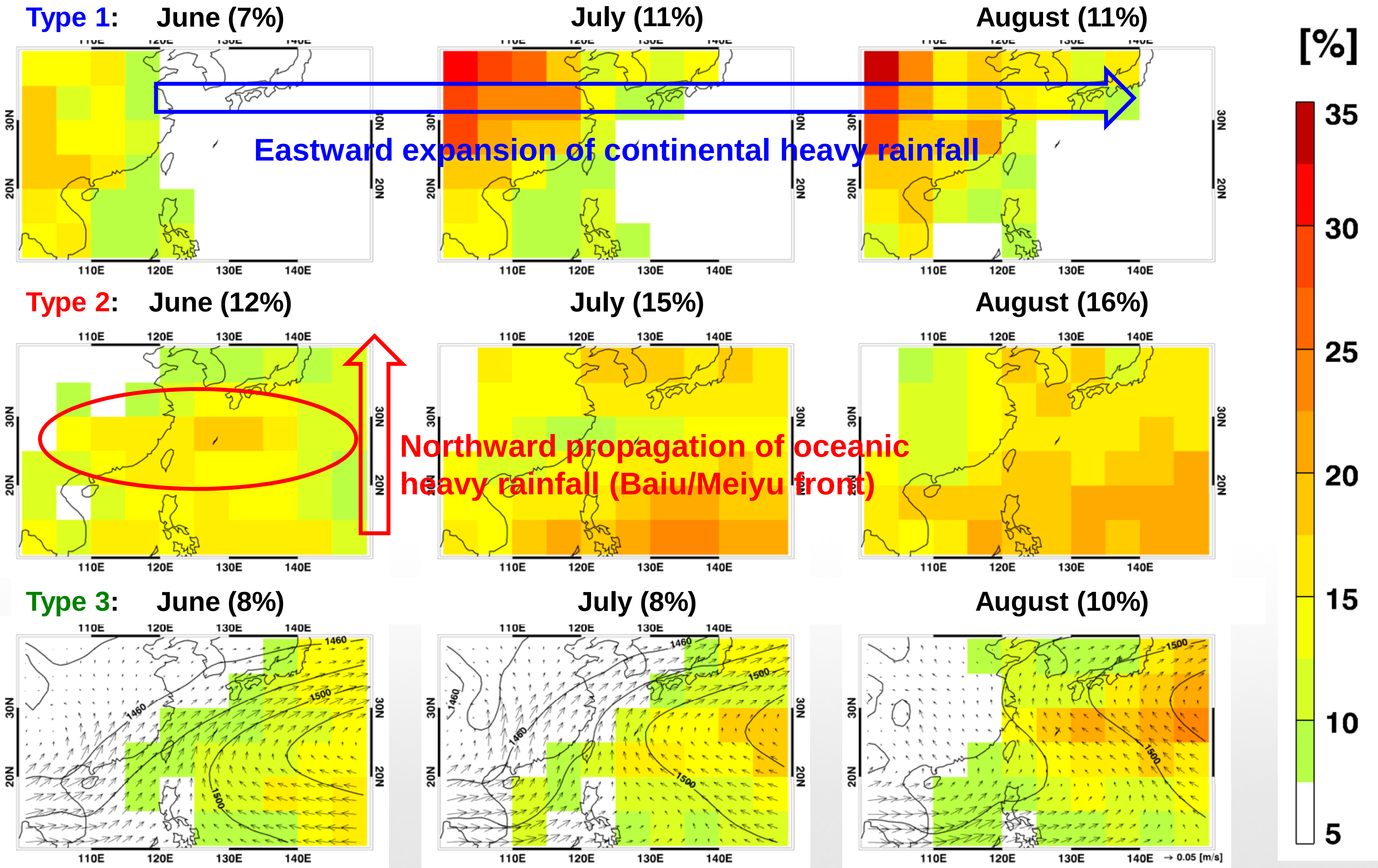
K-mean clustering, TRMM/PR & ERA-Interim, JJA 2002-2011



Color: Occurrence frequency (%), Solid Line: $Z_{850\ hPa}$ [m], Arrow: $q\vec{V}_{850\ hPa}$ [m/s]

Analysis of Climatic Characteristics of Precipitation

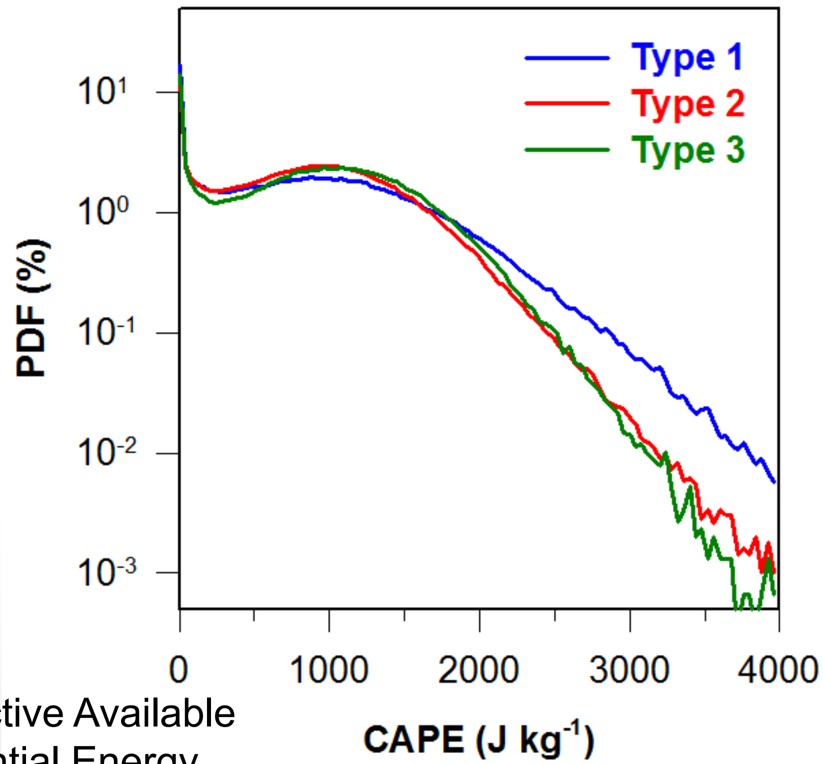
Seasonal Variation



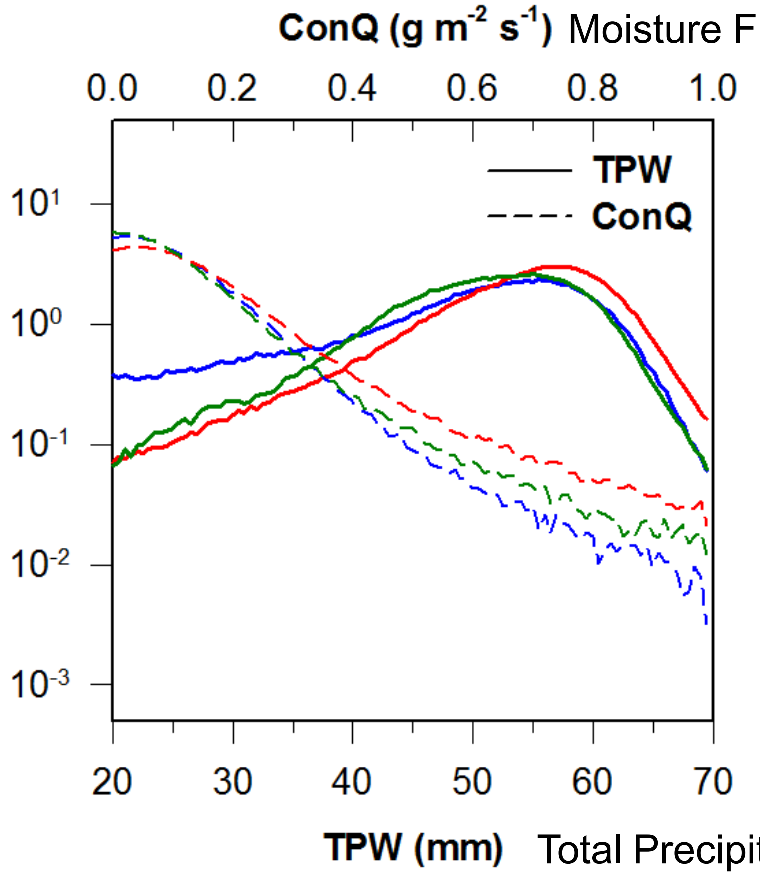
Analysis of Climatic Characteristics of Precipitation

Environmental Conditions

Method: Two adjacent 6-hourly ERA-Interim reanalysis data were interpolated to match the instantaneous TRMM/PR observation time during JJA 2002 ~ 2011.



Convective Available Potential Energy



Moisture Flux Convergence

Total Precipitable Water

Cold-type heavy rainfall

Convective instability

Warm-type heavy rainfall

Humid environment and strong moisture convergence

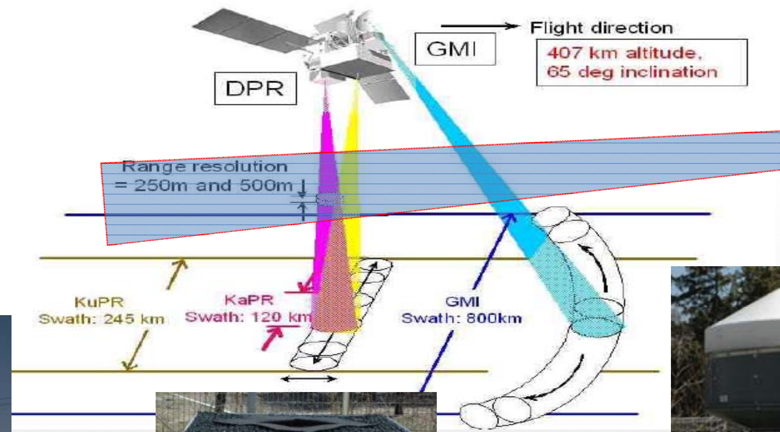
Precipitation Mechanism based on ground-based instrumentations by GyuWon Lee (Kyungpook National University)

Purpose

1) **To investigate microphysical/precipitation processes by combining GPM/DPR, ground based radars (VertiX, scanning radars, cloud radar), and distrometers over Korean Peninsula with emphasis on cold microphysical processes**
2) Precipitation mechanism linked with the topographical characteristics and atmospheric environment around Korean Peninsula using GPM/DPR and ground-based radar networks

Expected Results

1) Microphysical understanding on precipitation system around Korean Peninsula
2) Precipitation mechanism and climatology related with topography and environmental conditions around Korean Peninsula
3) Advantage/weakness of GPM DPR algorithms and products



Dual-Pol scanning radar

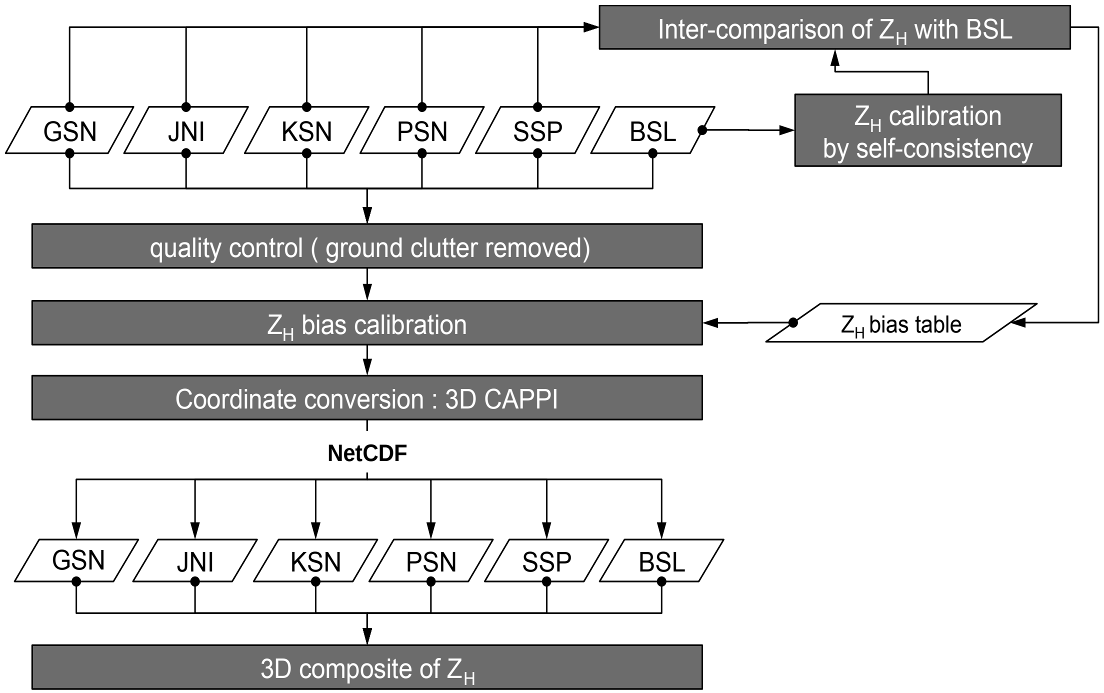
Ka-band cloud radar

2DVD

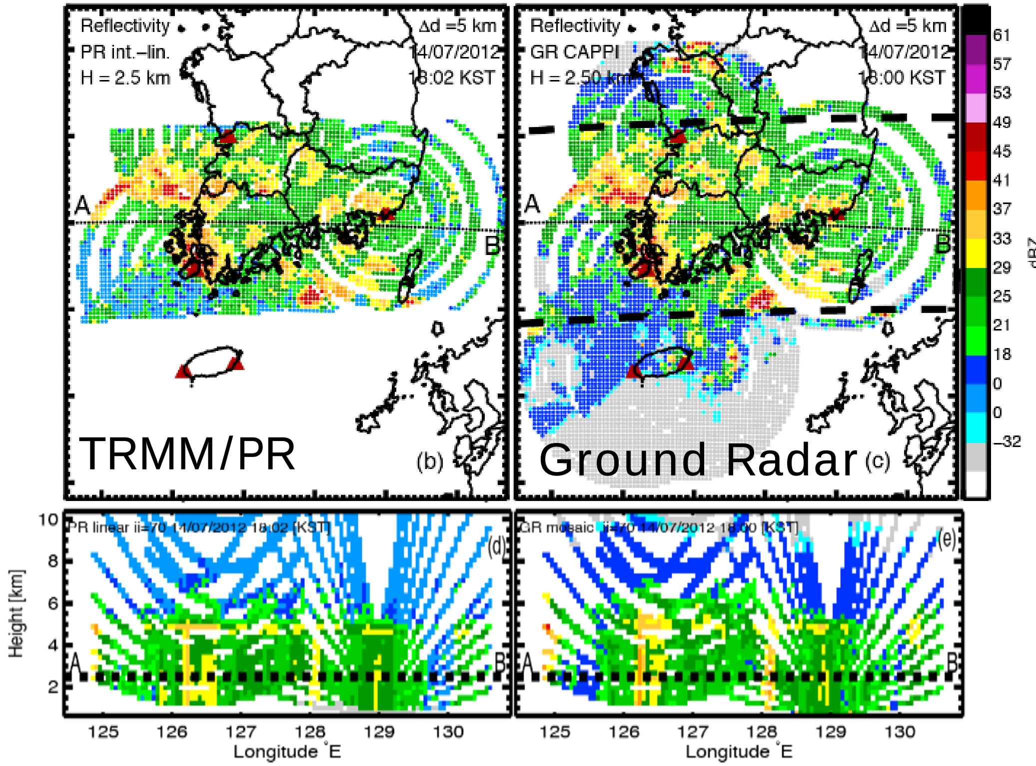
VertiX

Precipitation Mechanism based on ground-based instrumentations

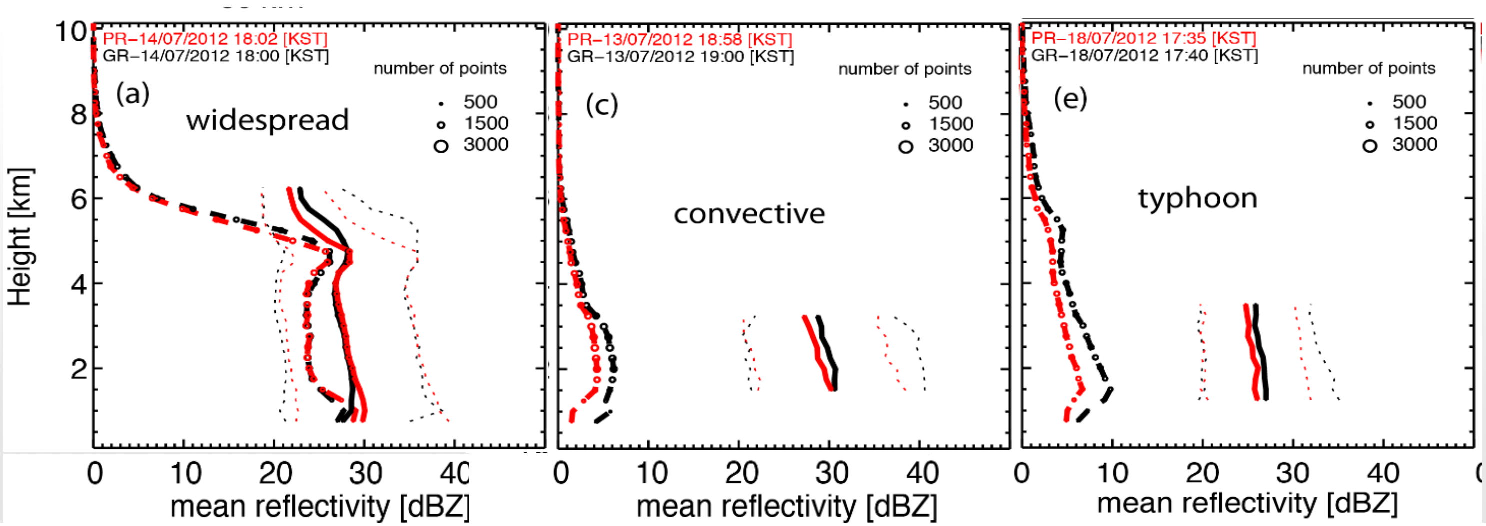
Generation of radar composite



Comparison at the common grid



Comparison of mean profiles for different precipitation system



Precipitation Mechanism based on ground-based instrumentations

Shallow Precipitation System (SPS)

H(BB) : height of BB, H(15): height of 15 dBZ

1) H(BB)-1km < H(15) < H(BB) + 3km

2) No bright band signature

3) Cellular structure in time-height reflectivity image

Overhang-type

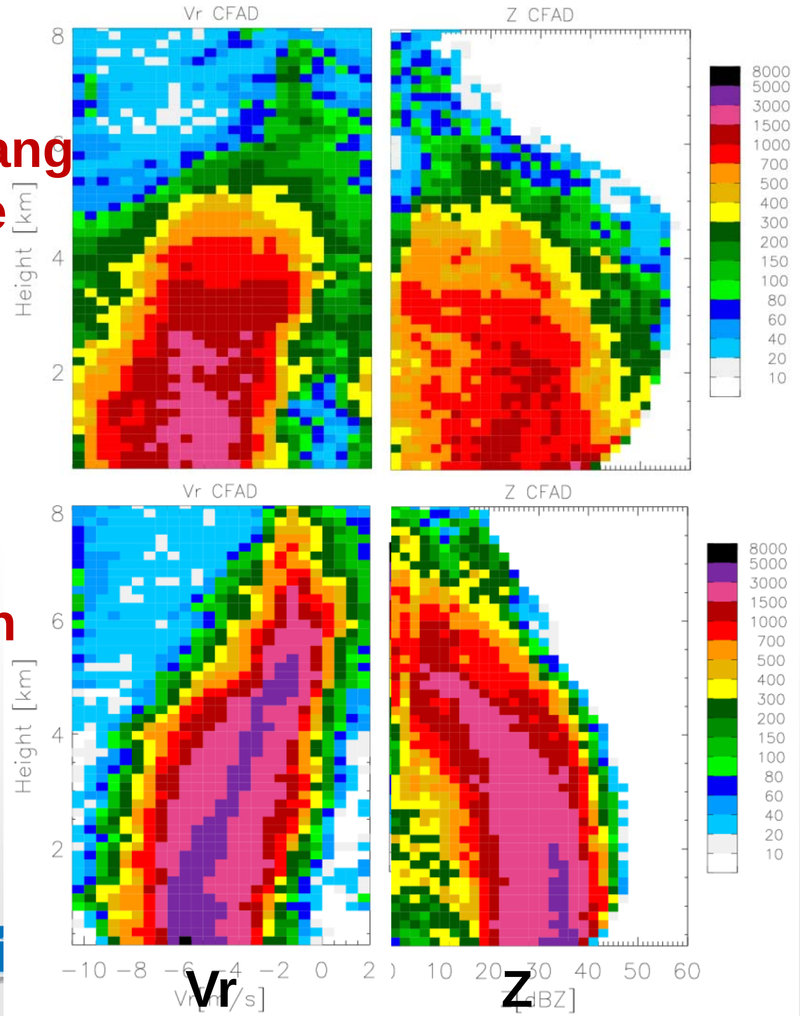
- No BB
- Rapid growth (5~6.5km)
- Constant Z (2-5km)
- Decreasing Z (below 2km)

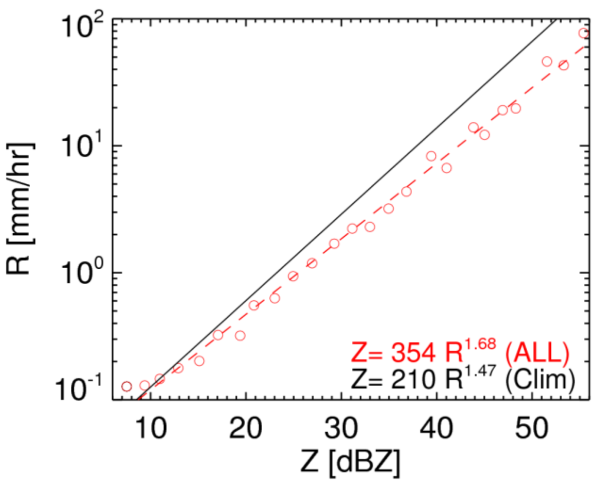
Growth-type

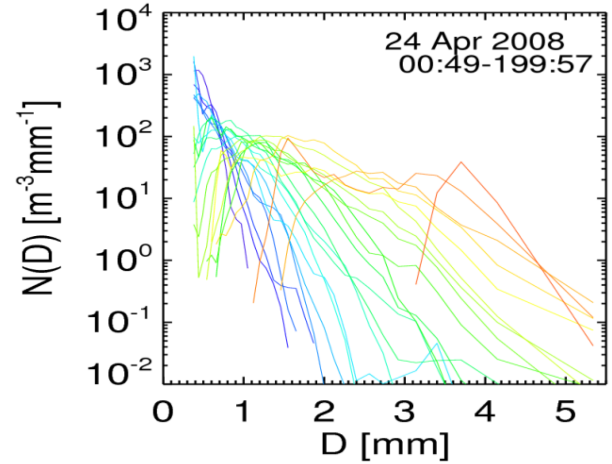
- No BB
- Overall increase of Z
- Gradual increase of Vr (<5km)
- Z bump at 6~7km

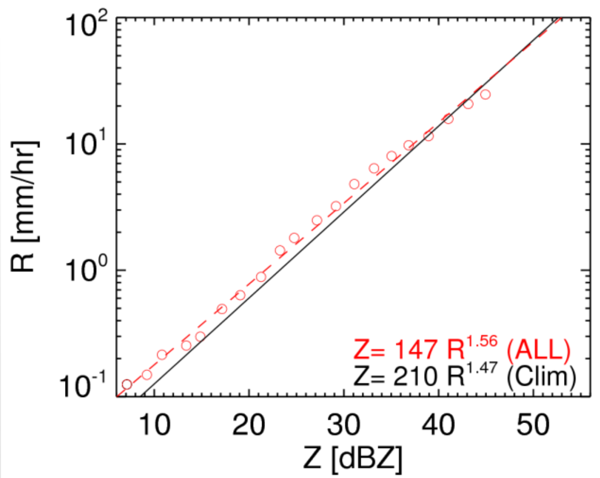
Overhang type

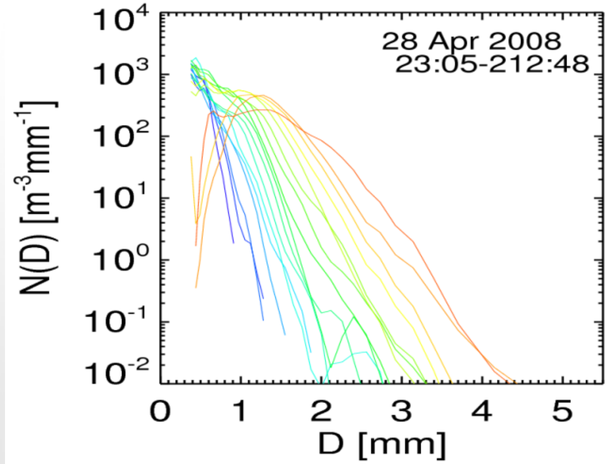
Growth type











Summary

- **Rainfall Characteristics in East Asia as Observed by TMI/GMI and PR/DPR**
  - The comparison of V7 rain retrievals from TMI and PR shows a very close correspondence between the two estimates, but a detailed look by rain type and geographical region reveals that many discrepancies still exist.
  - The disagreement predominately occurs for convective rain type and over the regions where clouds are mainly convective in nature
- **Analysis of Climatic Characteristics of Precipitation**
  - Warm-type heavy rainfall is frequently occurring over the humid region (including Korea and Japan) along the western periphery of the North Pacific high, in contrast to the cold-type heavy rainfall, generated under convectively unstable conditions over the China continent.
- **Precipitation Mechanism based on ground-based instrumentations**
  - A prototype of reflectivity intercomparison has been developed by matching up the TRMM/PR reflectivity and ground radar reflectivity composite and comparison of mean profiles for different precipitation system was performed.

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Status on KMA-JAXA Collaboration

❖ The 6th Collaboration Meeting in Seoul (Sep. 2013)

- Main Topics : Plan for GPM/DPR GV after launch in Korea
- KMA came to an agreement with JAXA for the participation of DPR quick evaluation GV in Korea.
  - "The plan for quick evaluation of GPM/DPR over the Korean Peninsula" has been established in December 2013.
- Discussion on orographic rainfall over Korea and feedback for comparison result between AWS rain rate and TRMM/PR rain rate

❖ DPR Quick Evaluation Plan over the Korean Peninsula

- **Objectives**
  - To examine the performance of GPM/DPR measurement by comparing with TRMM/PR and ground-based instruments in Korea
- **Observation Network**: AWS, ground-based radars, intensive observation sites
- **Methodology**: Validation Network (VN) for GPM, GR composite in common 3D grid
- KMA is ready for the validation activity right after launch of GPM core satellite.

THANK YOU