

The background of the slide is a photograph of the research vessel R/V Mirai. The ship's white hull and a prominent yellow mast structure are visible on the right side. The mast is equipped with various scientific instruments, including radar and sensors. The ship is sailing on a deep blue ocean under a bright blue sky with scattered white clouds.

***Validation experiments of GPM/DPR
on the pure-oceanic precipitating clouds
by instruments on board R/V Mirai***

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JAXA PMM PI Workshop @ Tokyo (Jan.15-17, 2014)

Background

- For better rainfall estimates by TRMM/PR and GPM/DPR, some more factors should be validated:
 - Uncertainty in algorithm, such as
 - Drop-size distribution
 - Vertical profile of rain (btwn. lowest measured bin and surface)
 - Estimated rain profile and surface rainfall
- Large differences between continental and **oceanic precipitation** characteristics have been reported in previous studies
- Even very small landmass affects to the cloud and rain, though most of the data for oceanic rain were obtained over islands.

Ground truth over **pure-oceanic** background is desired
to better estimates of rain over ocean

Outline of the Project

Utilizing *R/V Mirai*
to operate GV instruments in pure-oceanic region



Long-Term Observation

- All available cruise in 2013-2015, incl. Arctic, mid-lat, and Tropics
- Continuous observations by automatic instruments
- Cover both TRMM/PR and GPM/DPR eras

Intensive Observation

- In particular cruise for precipitation systems (2015, Tropical Indian Ocean)
- Operates Ka- and X-(or S-) band vertically-pointing radar
- Direct comparison to GPM/DPR
- Welcome other instruments, esp. videosonde, Ku-band radar

Research Vessel (R/V) *Mirai*

- Owned by Japan Agency for Marine-Science and Technology (JAMSTEC)
- One of the biggest research vessel (L:128m, GT:8687t)
- Cruises tropical, mid-latitude and polar regions
- A few to several cruises each year
- Each cruise (one to several months) is for particular mission
- Piggy-bag missions are available for every cruises



Planned / Possible Observations on R/V Mirai

Occasional
Special Obs.
(by *Mirai*
original
instruments)

C-band Scanning
Doppler radar

Radiosonde

PMM Long-term Obs. for 3 years

<<< DSDpack >>>

Joss-Waldvogel Disdrometer

Optical Disdrometer (LPM)

Optical Disdrometer (Parsivel)

Optical Raingauge

Micro Rain Radar (K-band VP)

Continuous
Obs.
(by *Mirai*
original
instruments)

Raingauges
- optical
- capacitance

Surface Met.
(T, P, RH,
Wind, DLW,
DSW, etc.)

Ceilometer

Wave Height

Surface
Seawater
Monitoring
(Temp.,
Salinity, etc.)

PMM
Intensive Obs.
for 2015 IO
cruise

Ka-band VP radar

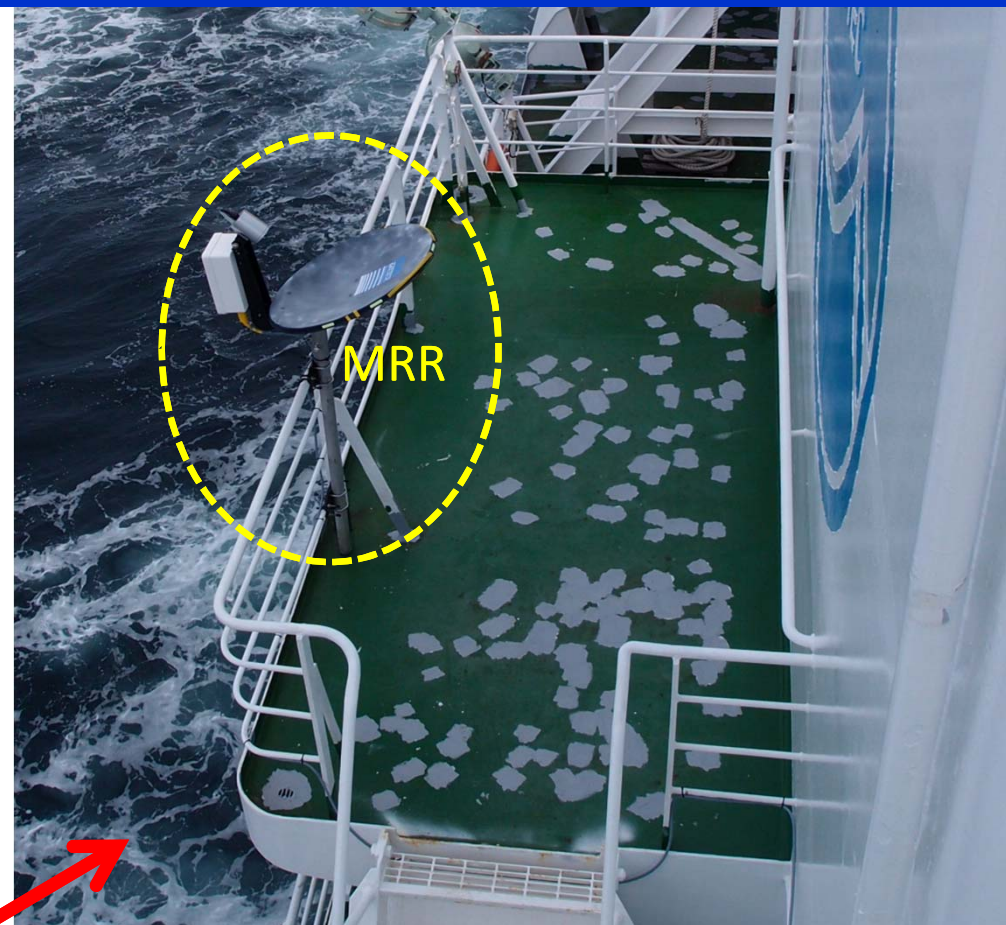
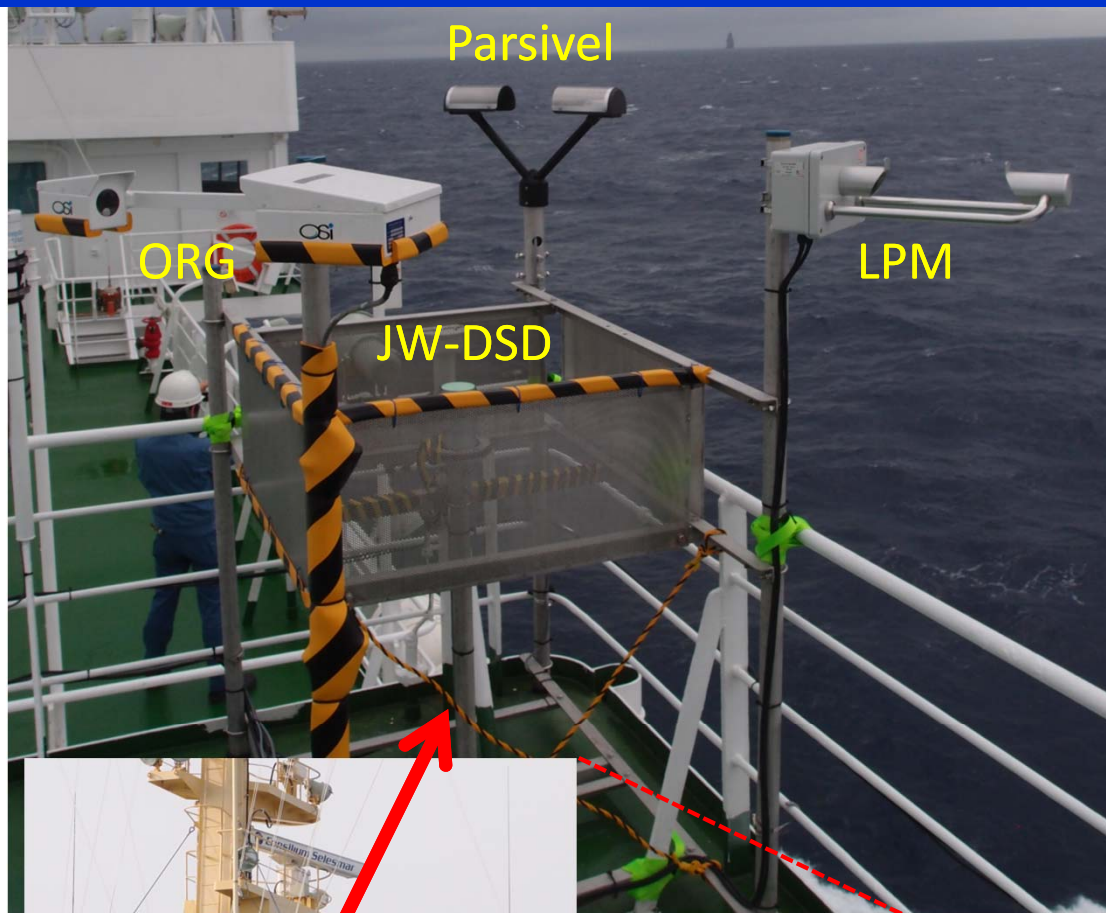
X- (or S-)band VP radar

(Ku-band VP radar) (*expected*)

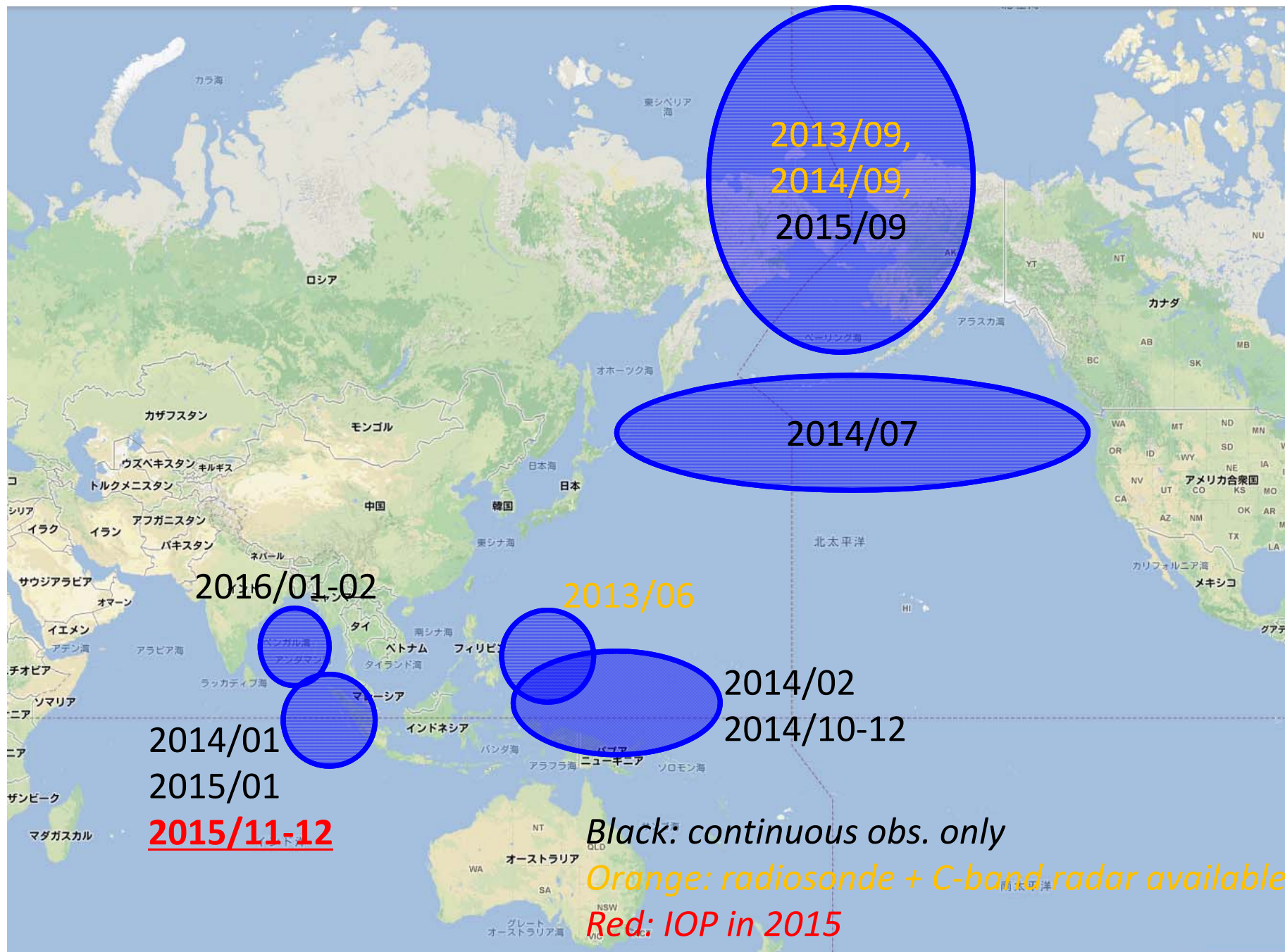
(Videosonde) (*expected*)



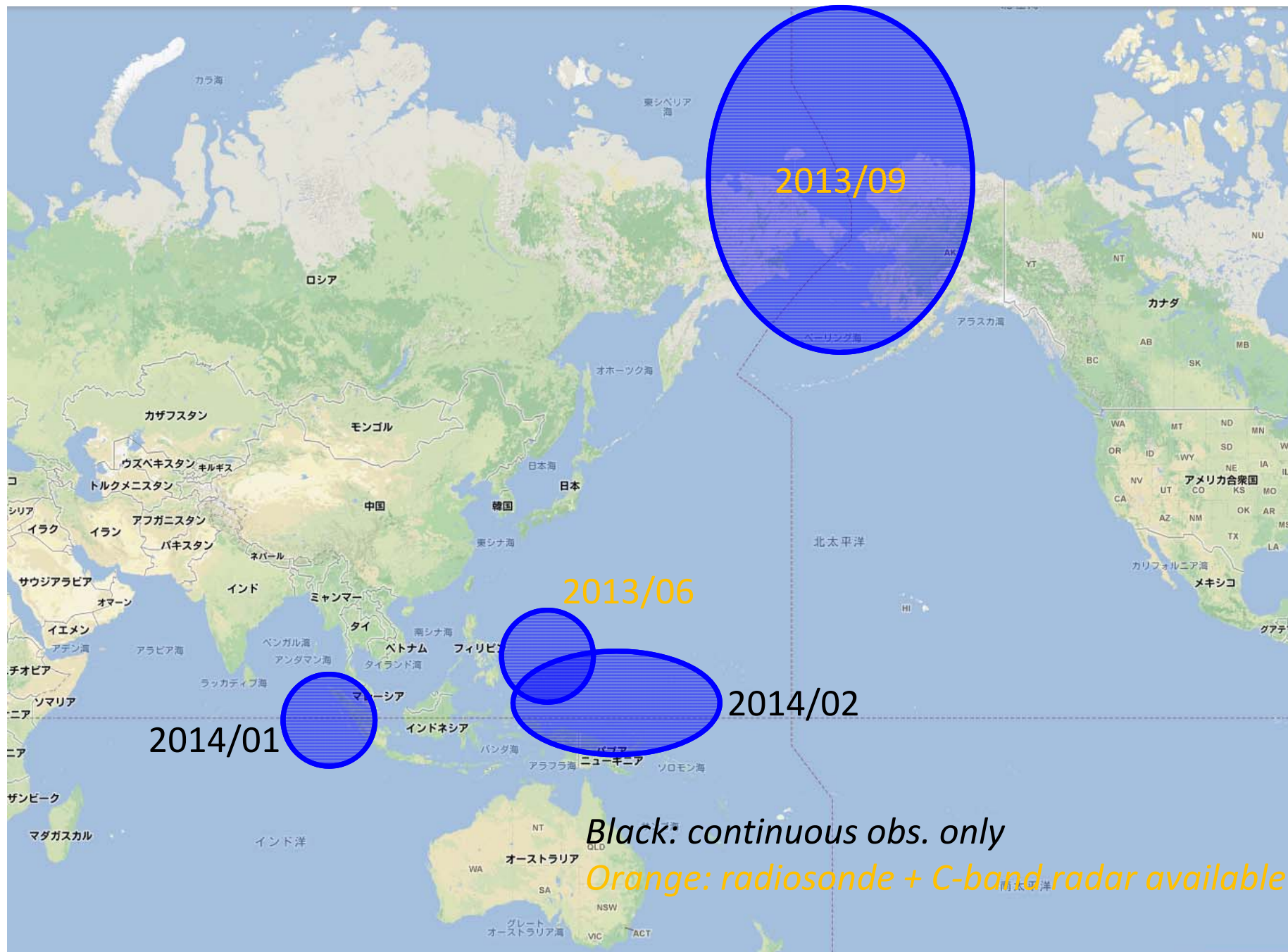
DSDpack on R/V Mirai



Planned Cruises in 2013-2015



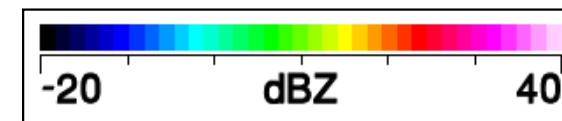
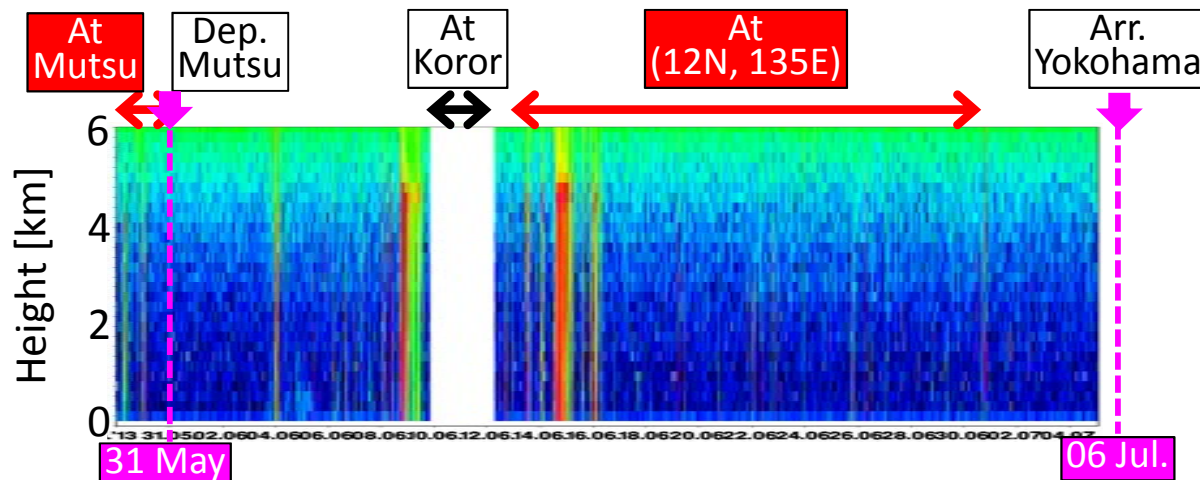
Completed / On-Going Cruises in JFY2013



Preliminary Results on Obtained Data

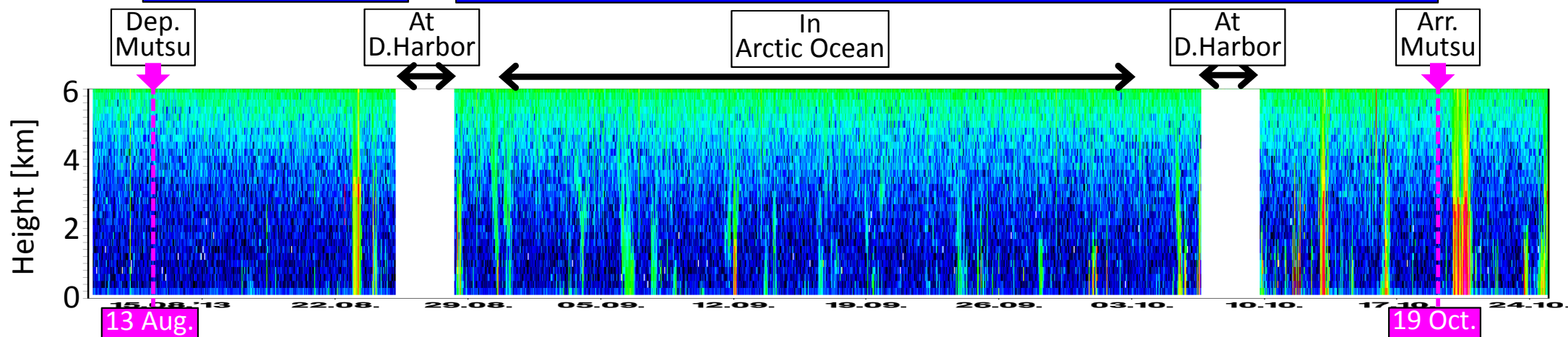
(being) obtained data in JFY2013: MRR radar ref. T-Z

MR13-03 (Tropical Western Pacific)



MR13-05 (N. Pac.)

MR13-06 (Arctic Ocean / North Pacific)

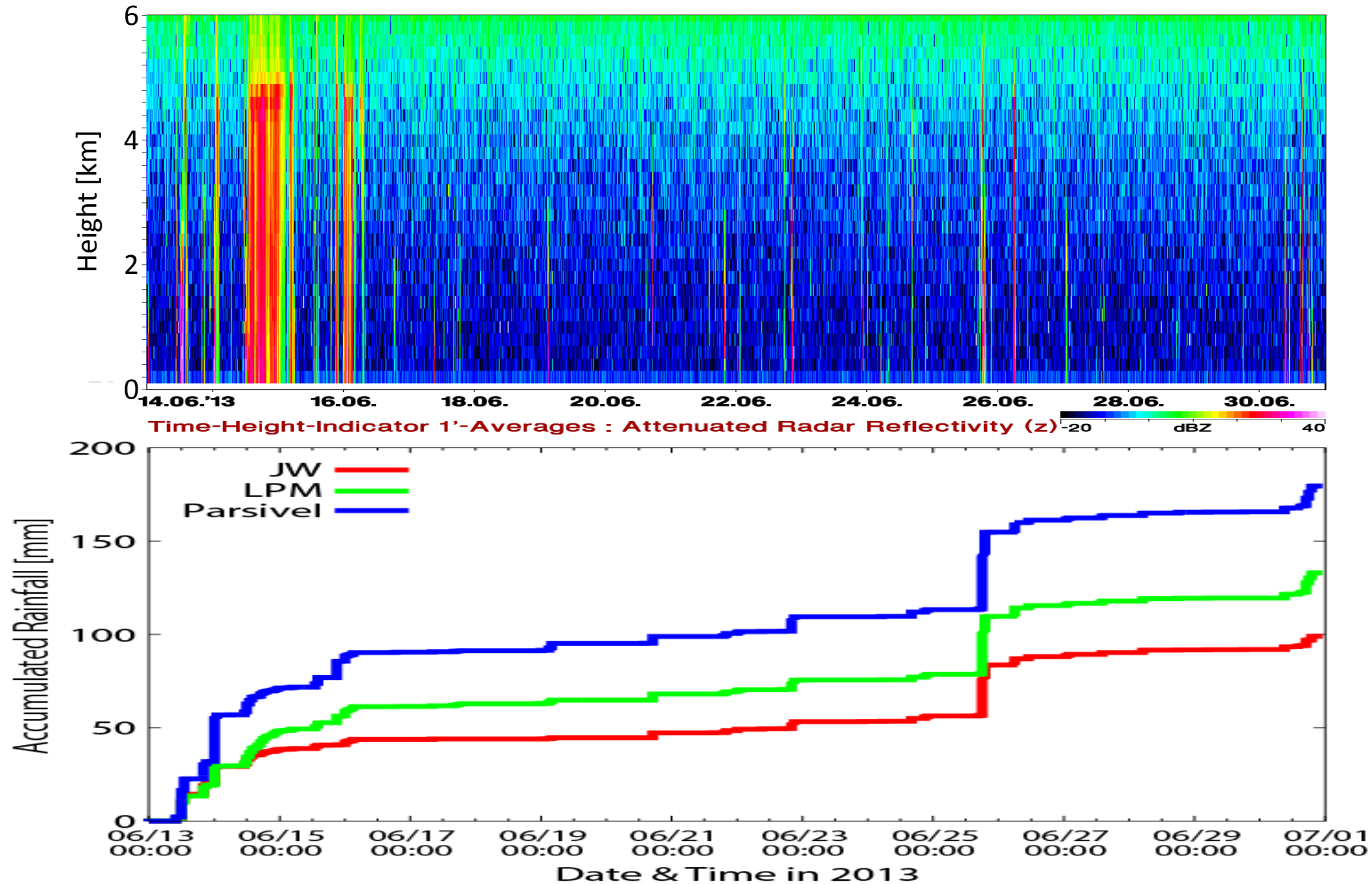


On-Going:

MR14-01 (Indian Ocean) [09 Jan. - 11 Feb.]

MR14-02 (Tropical Western Pacific) [13 Feb. - 22 Mar.]

Obtained data at (12N, 135E) in MR13-03 (Jun.2013, 18 days)



Vertical profiles of radar reflectivity by MRR

*Contoured frequency altitude diagram (CFAD)
of MRR “attenuation-corrected” reflectivity (Z)
(12N, 135E), Jun.2013 (18 days)*

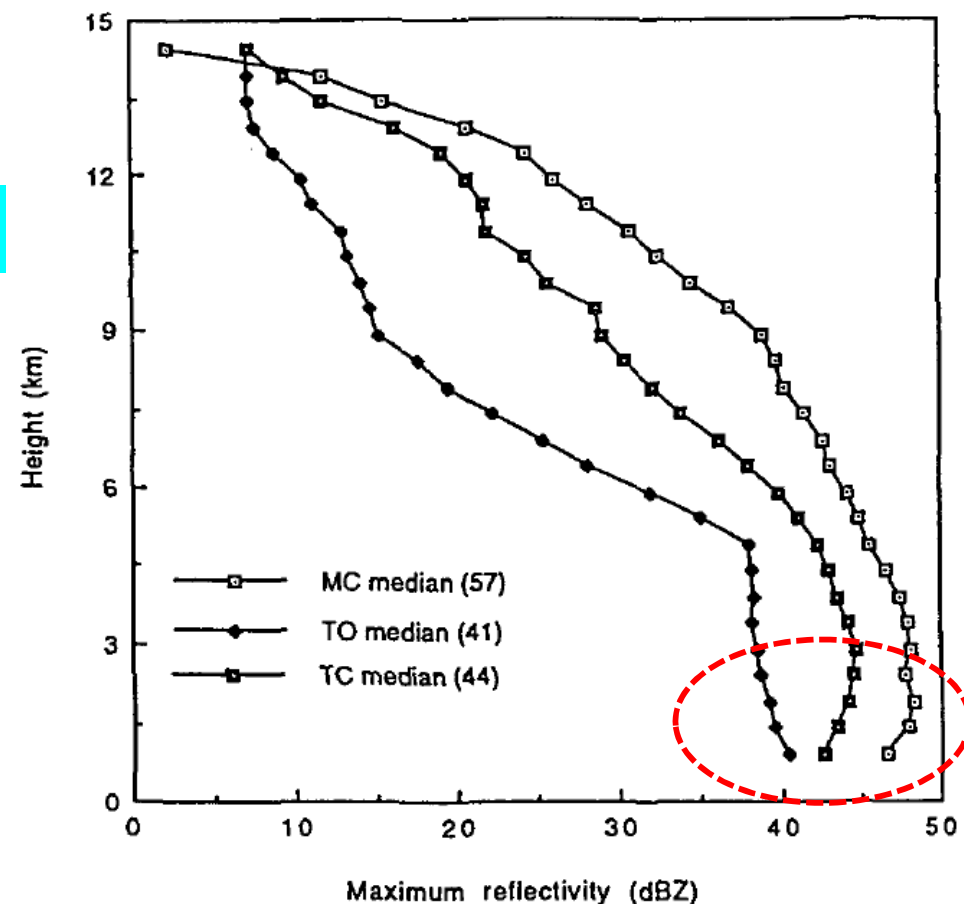
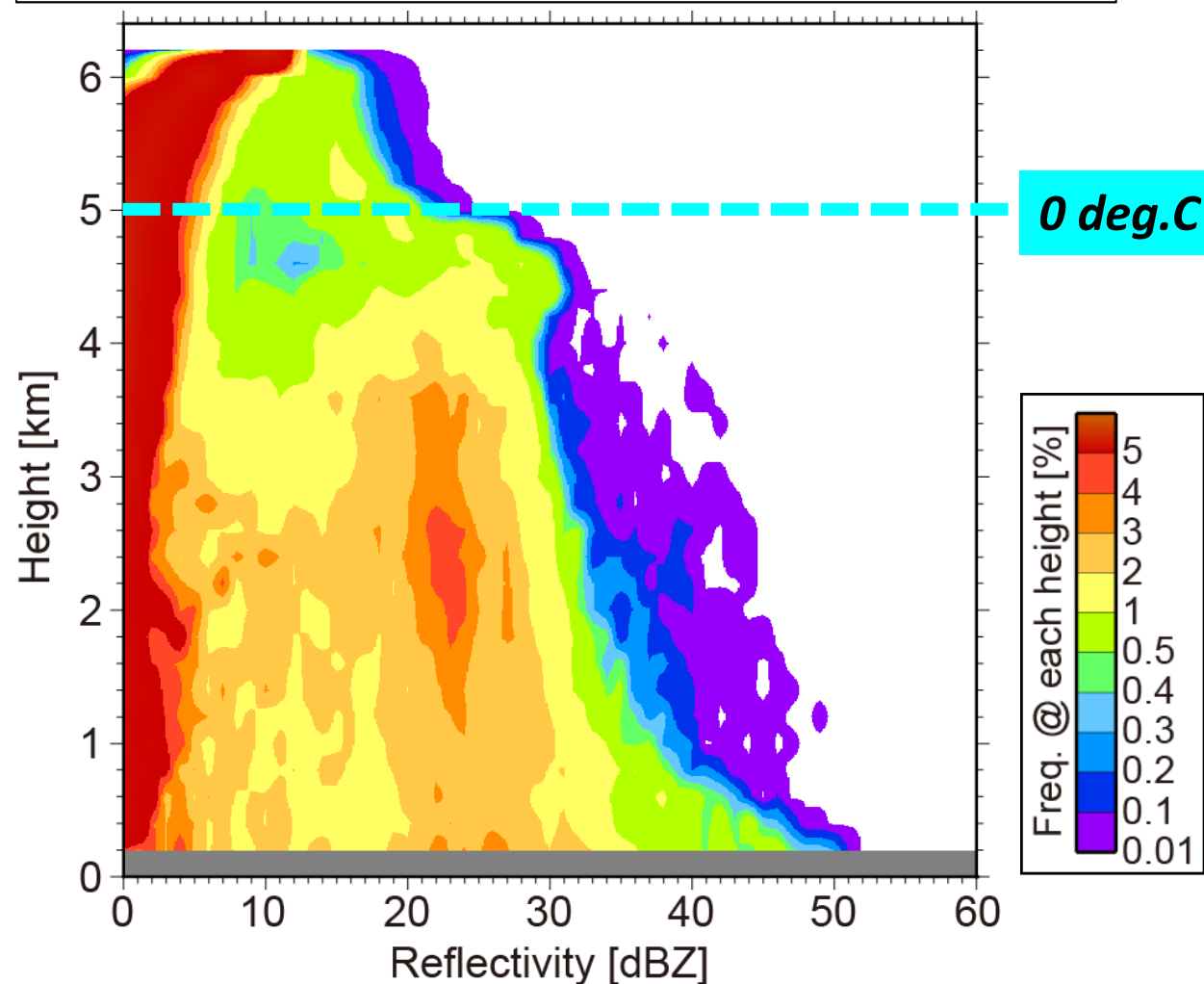
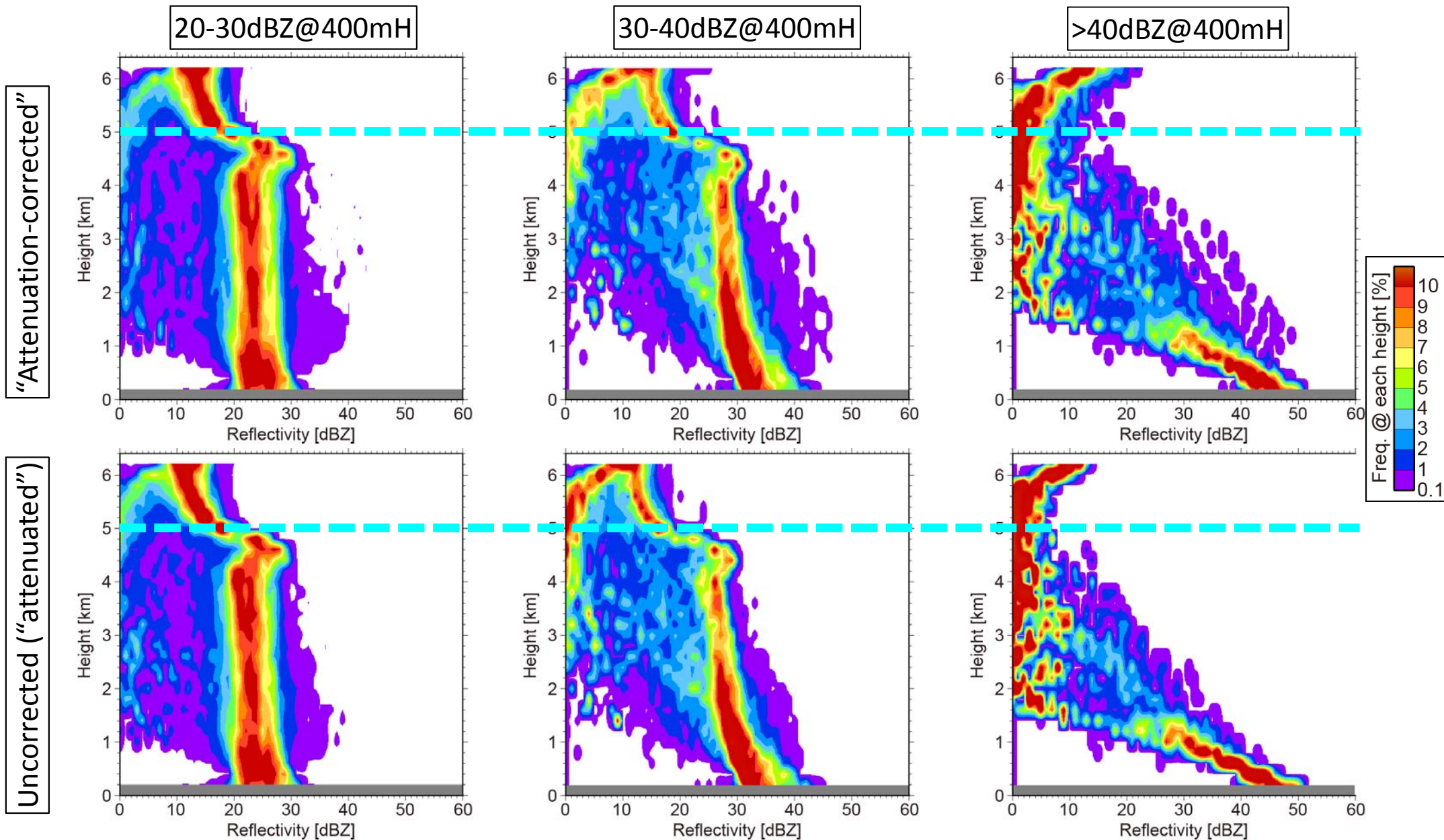


FIG. 3. Median VPRR from convective cells in the 41 tropical oceanic (TO) MCS events studied, 44 tropical continental (TC) MCS events studied, and 57 midlatitude continental (MC) MCS events studied.

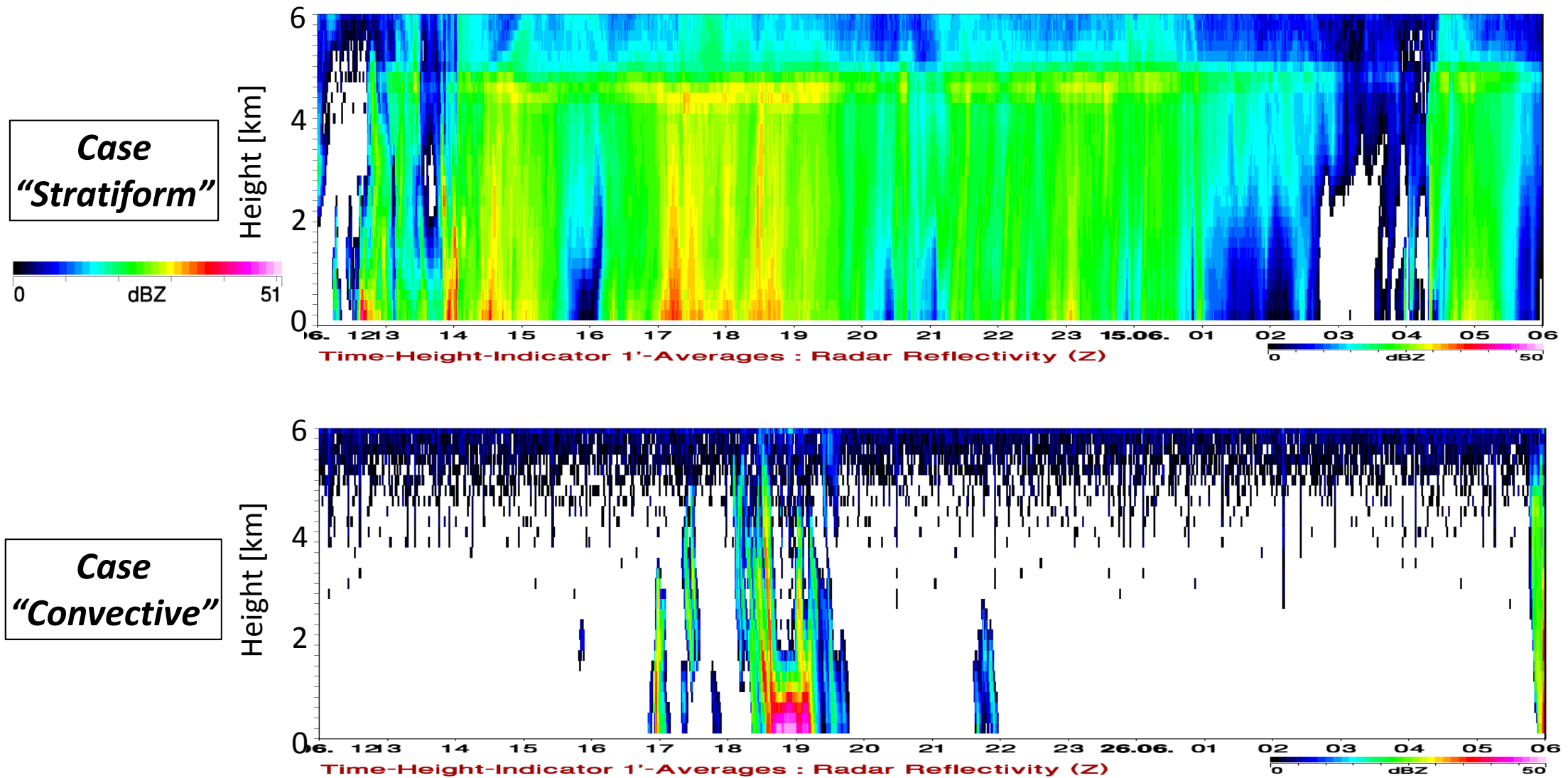
Zipser and Lutz (1994)

Vertical profiles of radar reflectivity by MRR

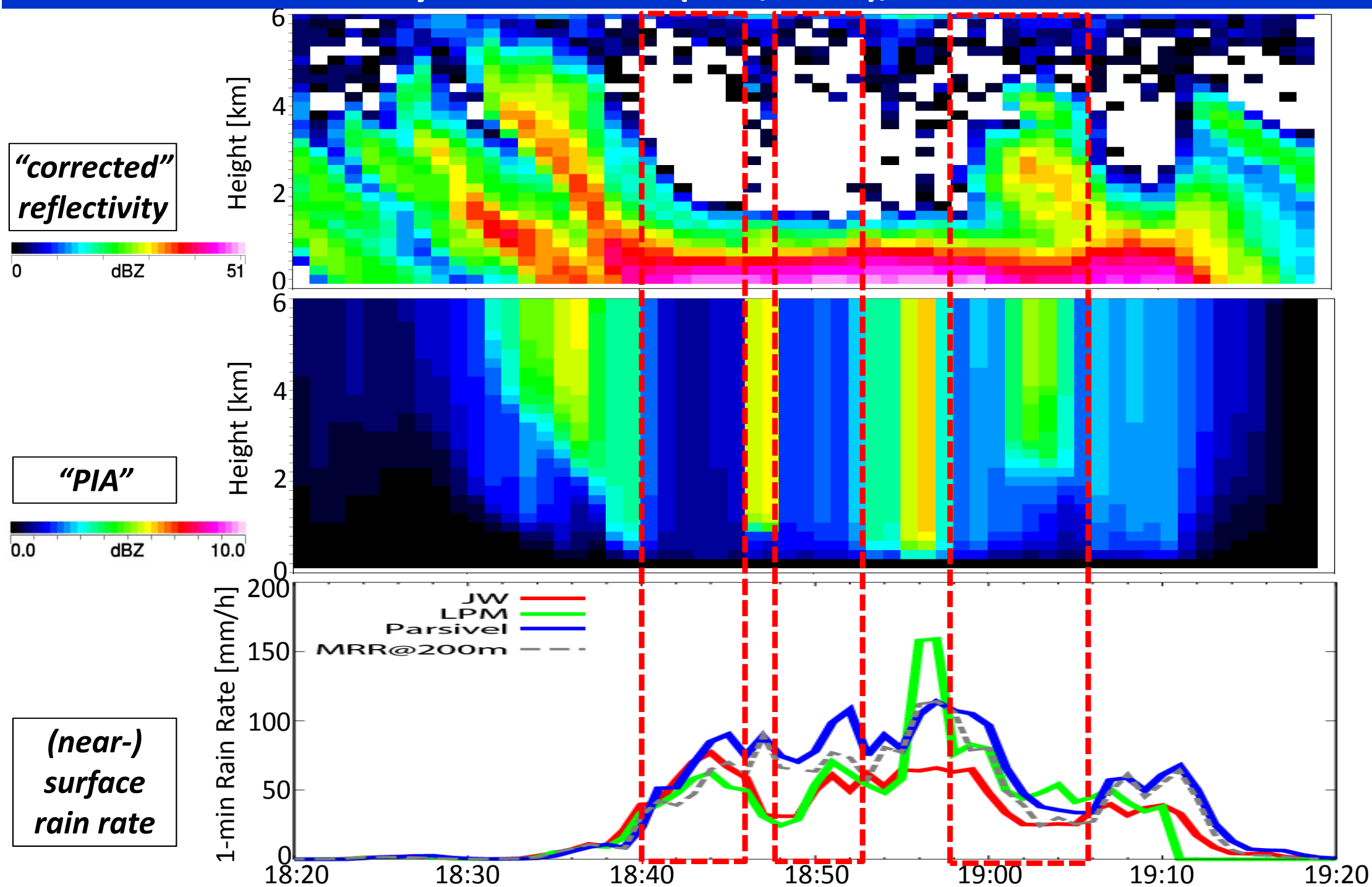
***CFAD of MRR radar reflectivity
(12N, 135E), June 2013 (18 days)***



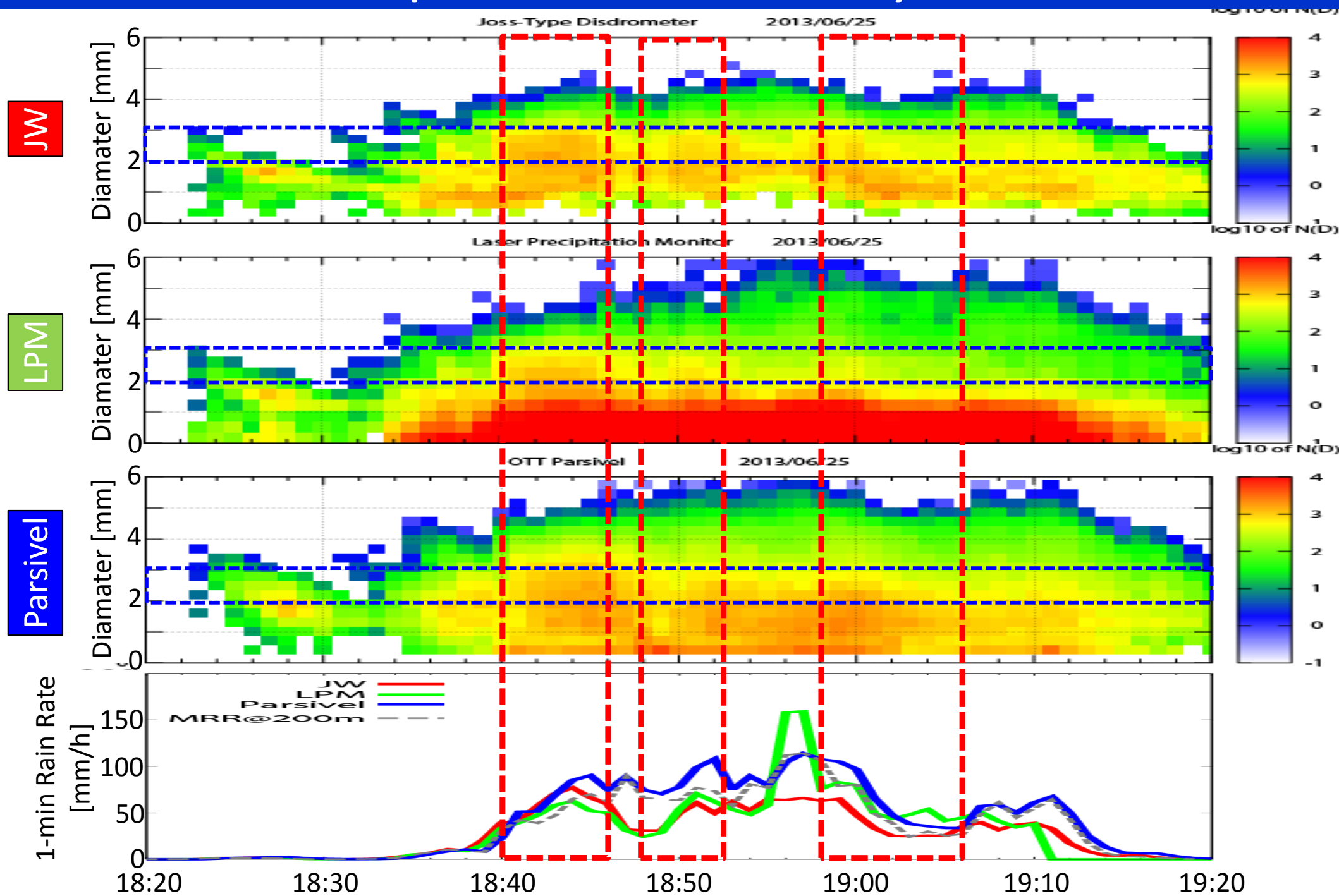
Vertical profiles of radar reflectivity by MRR



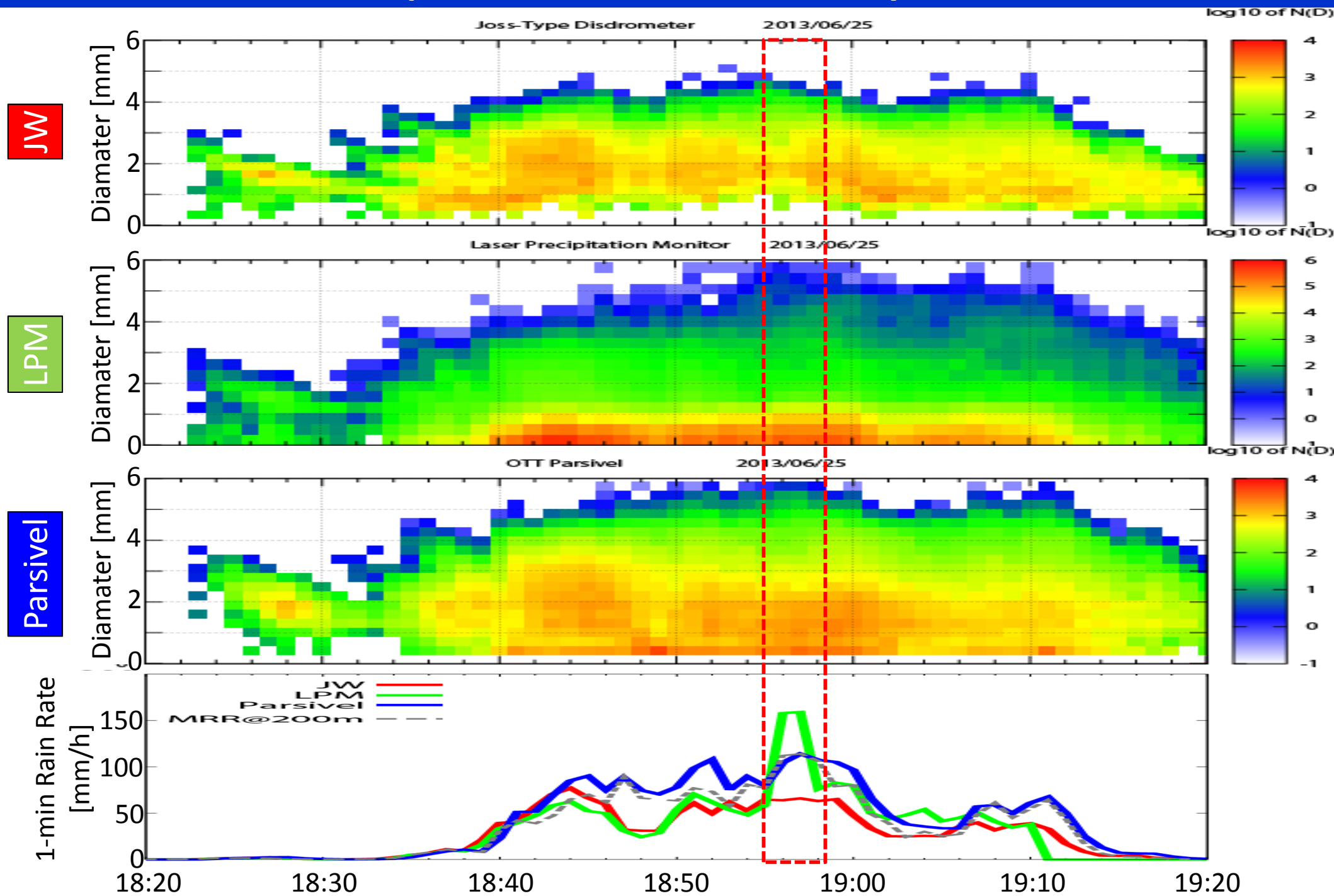
Heavy rain event at (12N, 135E), on Jun.25



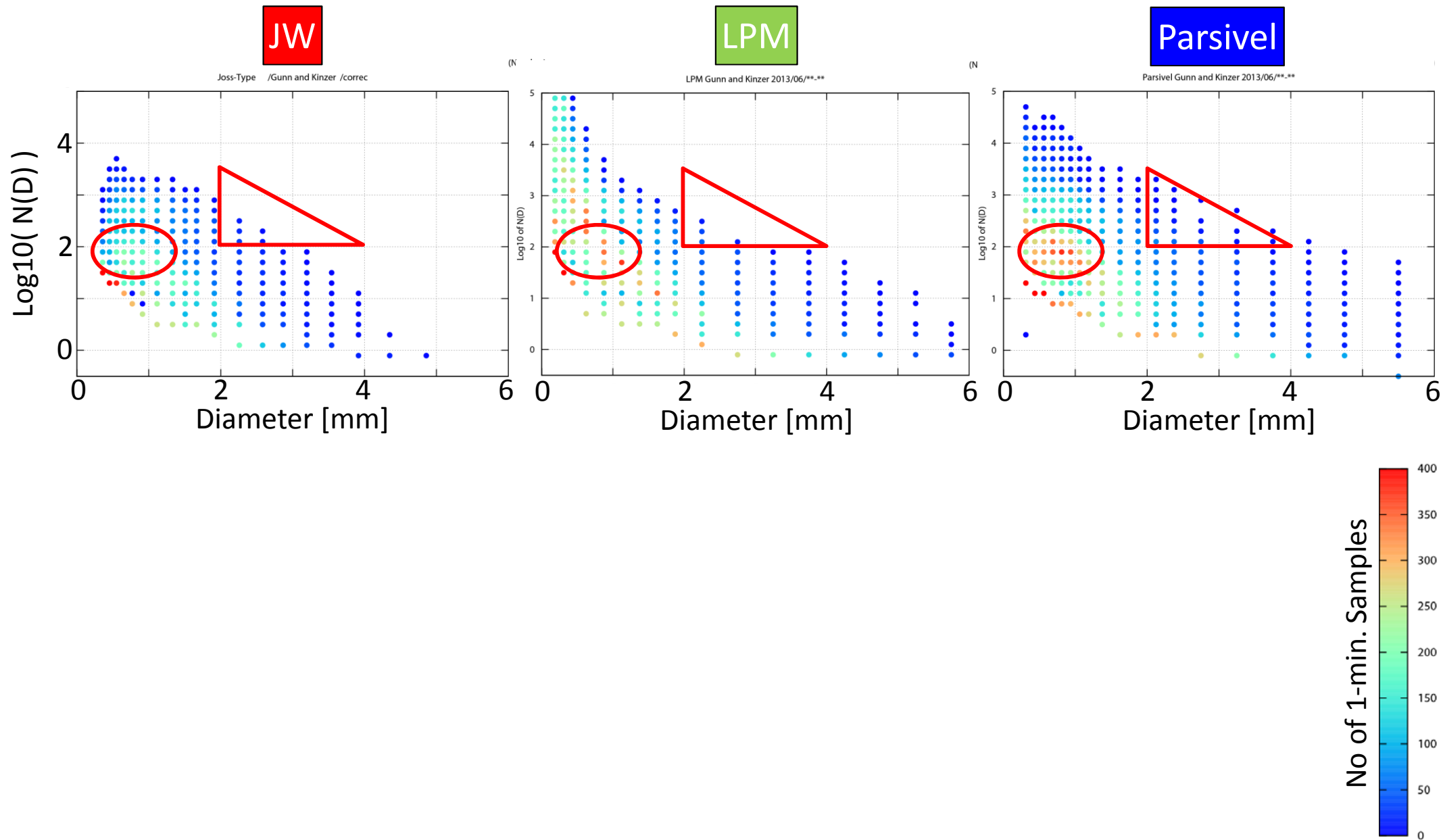
Observed drop size distributions in heavy-rain event



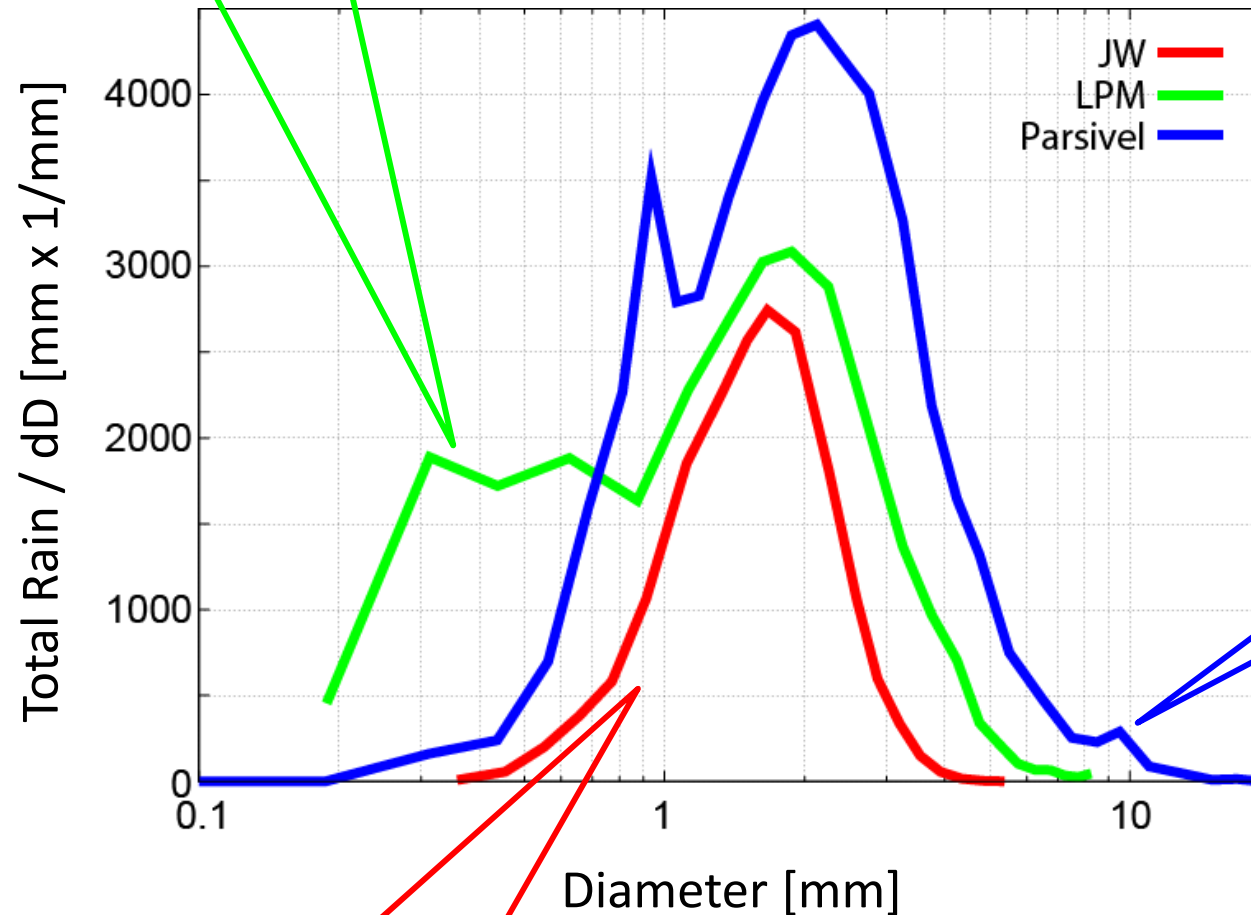
Observed drop size distributions in heavy-rain event



Preliminary Results



Rainfalls at each drop size: 12N135E, Jun.2013, 18days



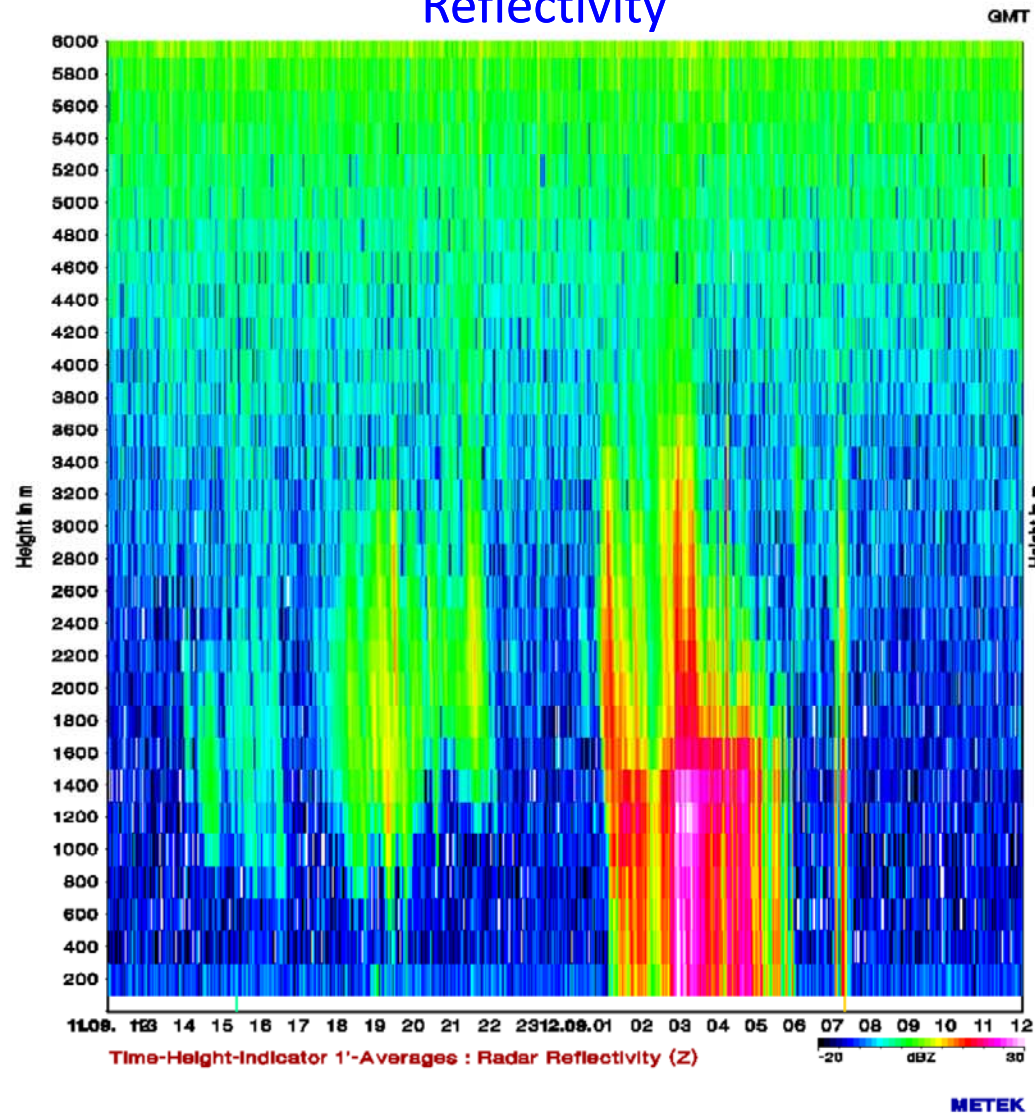
Too Many small drops ?

Too big drops ?

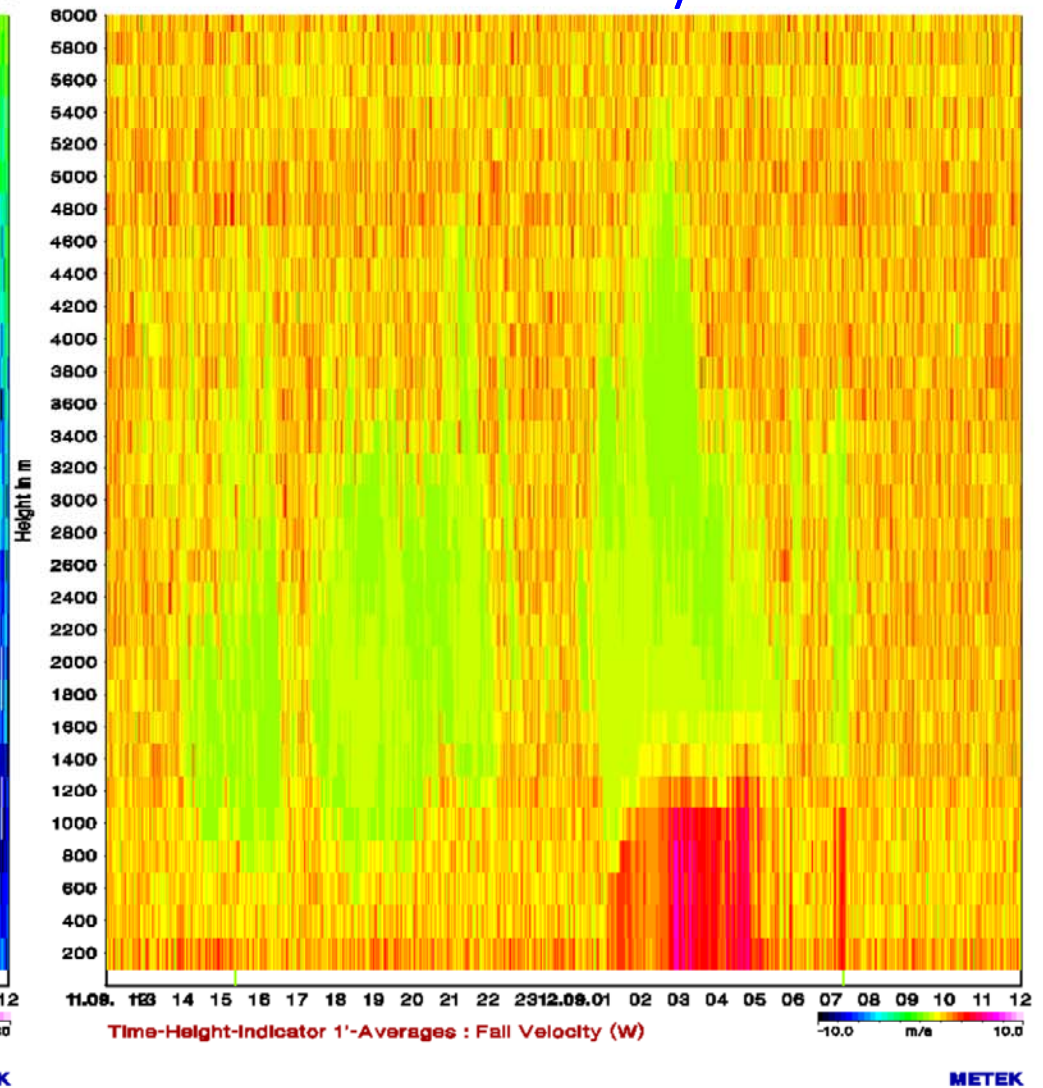
Too Narrow DSD ?

MRR example at Arctic Ocean : Sep.2013

Reflectivity



Fall Velocity



Summary

- Long-term observation (by disdrometers and micro rain radar) were successfully launched and continued
- Data processing and analyses are started
- On-board MRR has severe problem by attenuation by tropical heavy rain (insufficient attenuation correction ?)
- On-board disdrometers result different PSD characteristics on tropical rain, as
 - JW: severe dead-time effect, small number of big drops
 - LPM: large number of small drops
 - PW: very big drops
- Further analyses to examine data quality are required

- **Drop-size distribution**

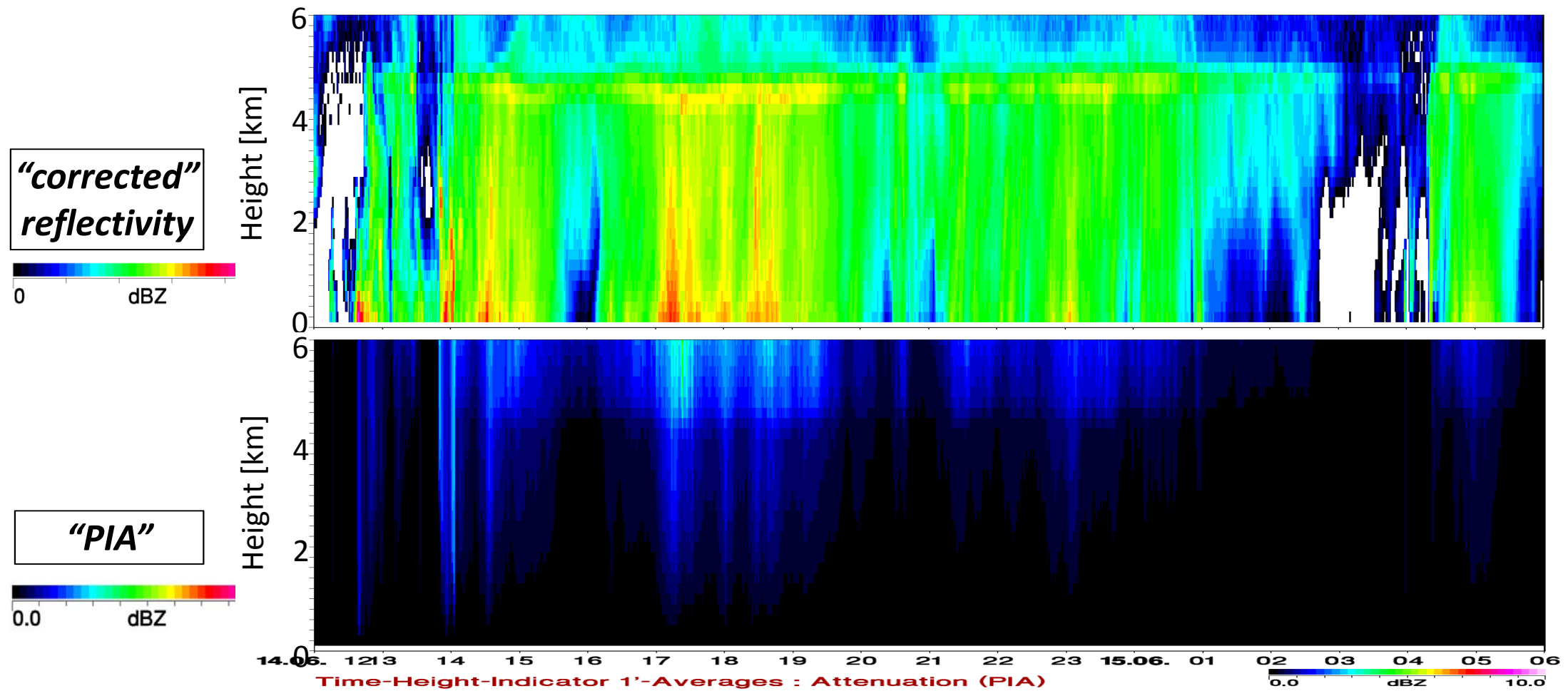
- Further evaluation of ship effect (movement / vibration), location, relative wind, etc. (by data analyses, further ground-based observation, etc.)
- Analyses on mid- and high-latitudes
- Comparison to previous land-based results

- **Vertical profile of rain / radar reflectivity**

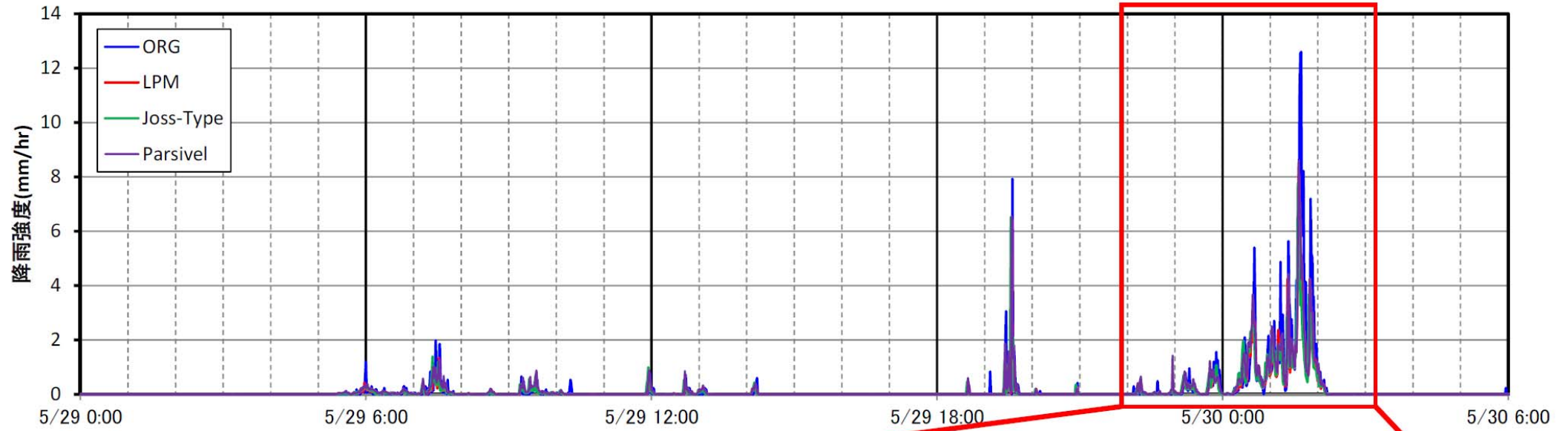
- Improve attenuation correction (utilizing disdrometer data ?)
- Comparison of lowest available data by MRR and surface gauge / disdrometer
- Analyses on mid- and high-latitudes
- Preparation for IOP (in 2015 in tropics): [Serious demands of multi-frequency observation and/or longer-wavelength radar \(to minimizing effect of attenuation\)](#)
- Utilization of new C-band radar data (will be upgraded in 2014)

Additional Slides

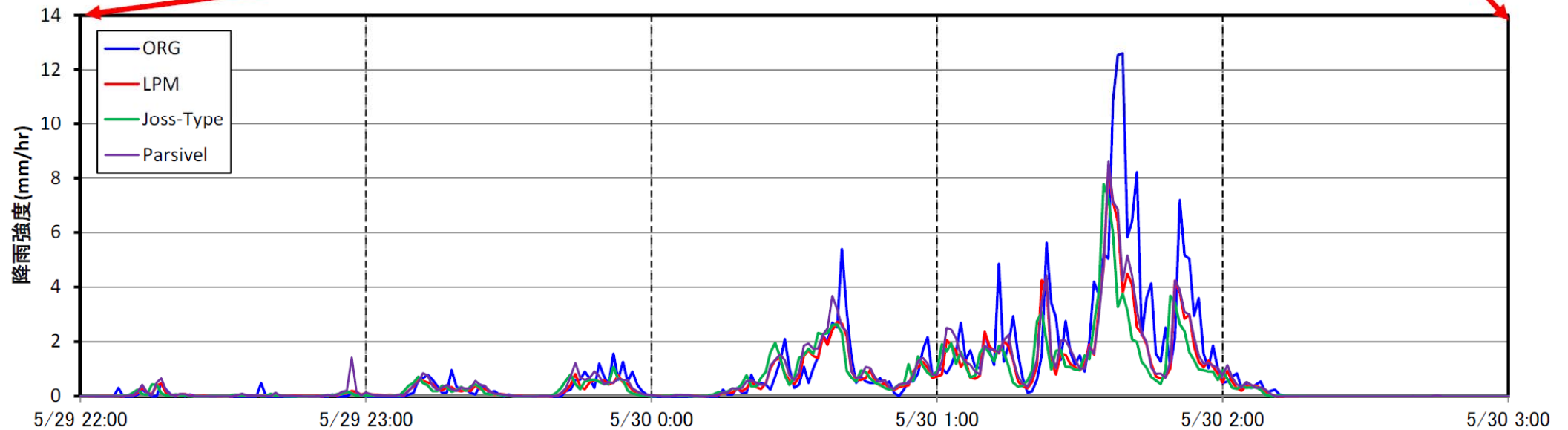
Tropics, Stratiform (Jun.14 12Z – Jun.15 06Z)



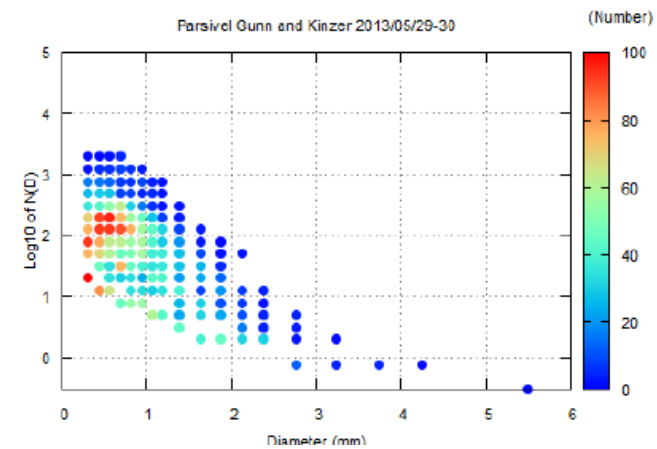
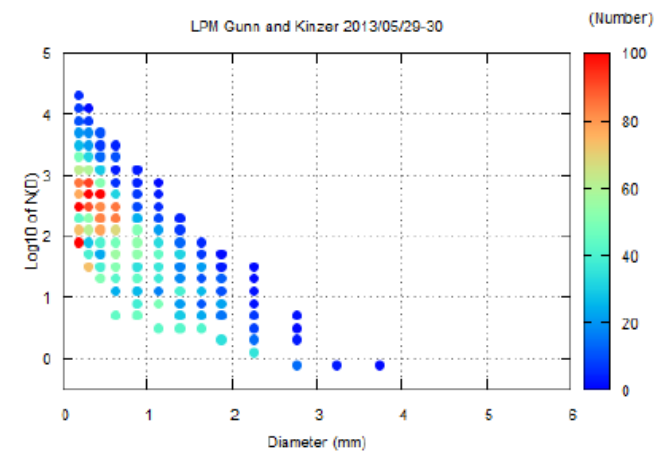
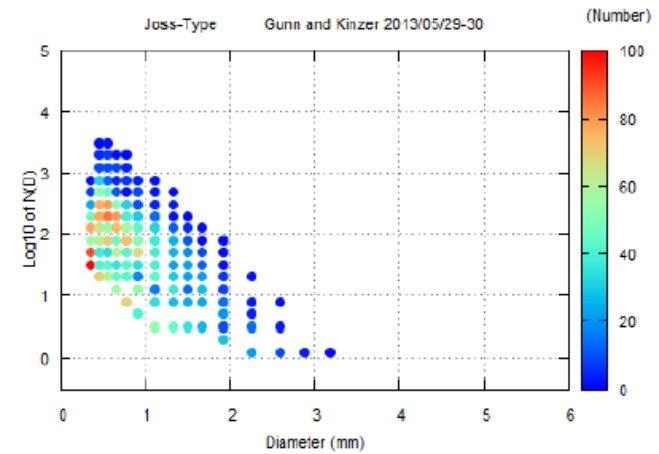
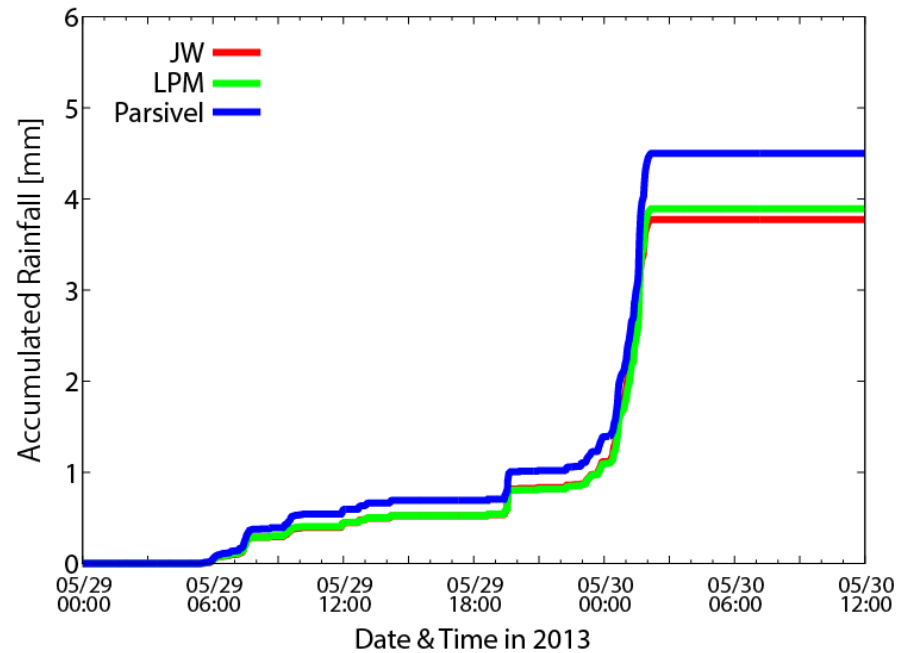
At Pier (1) Mutsu, May 2013



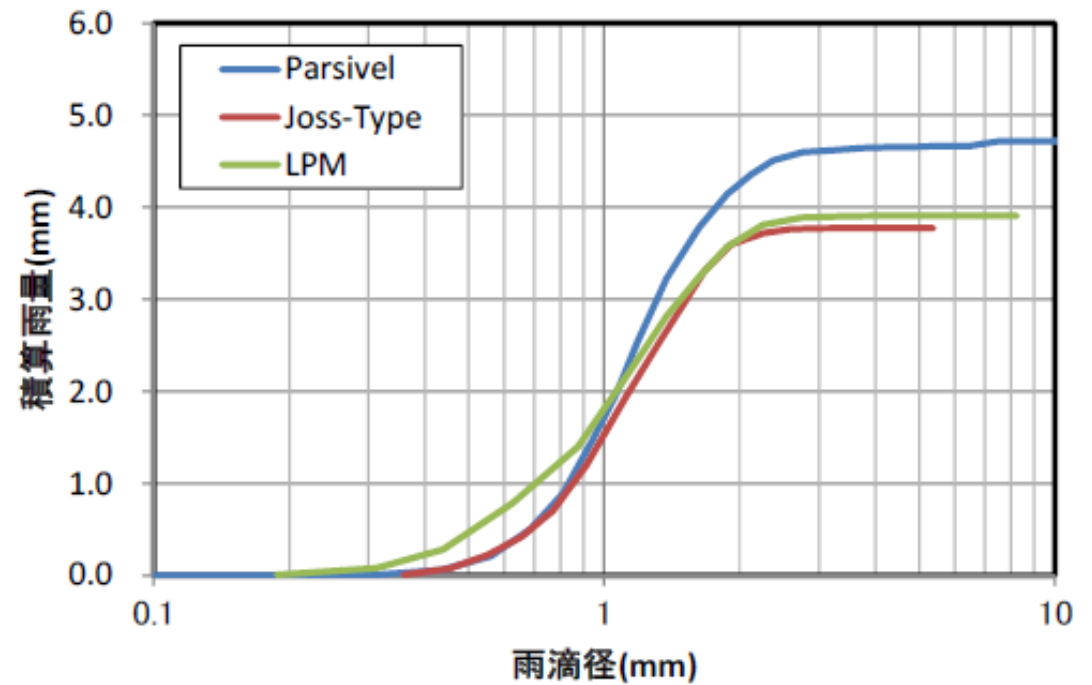
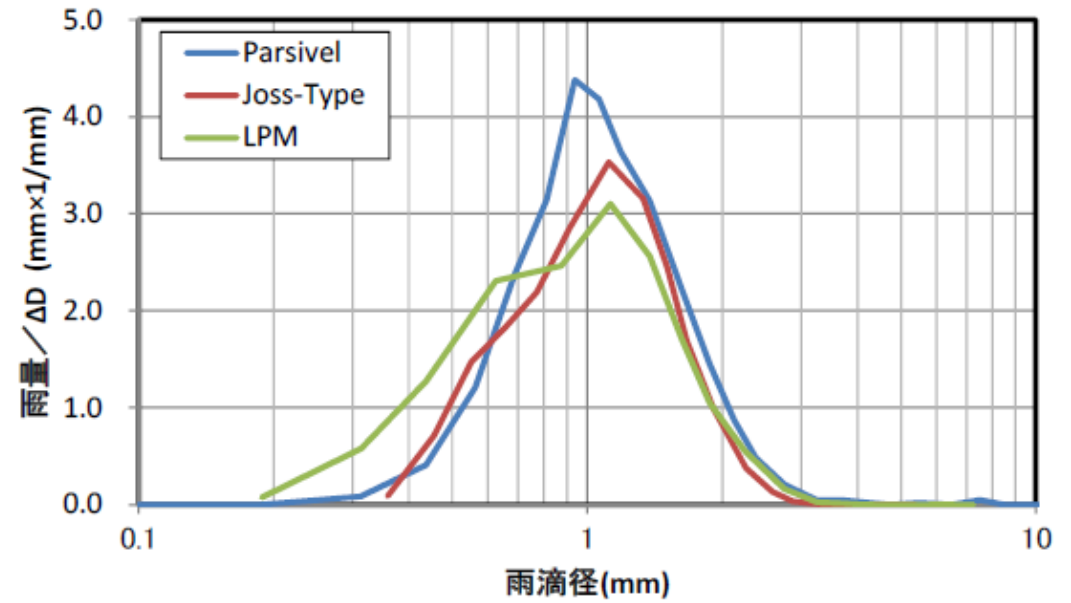
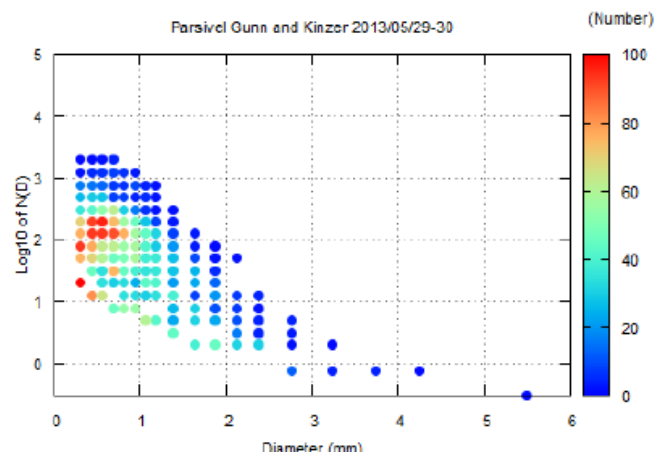
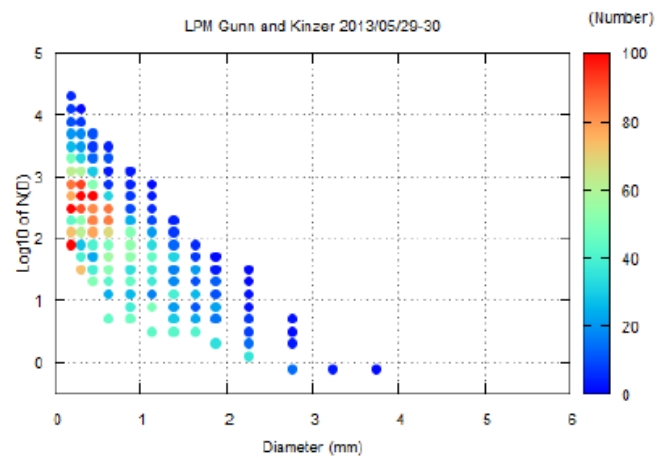
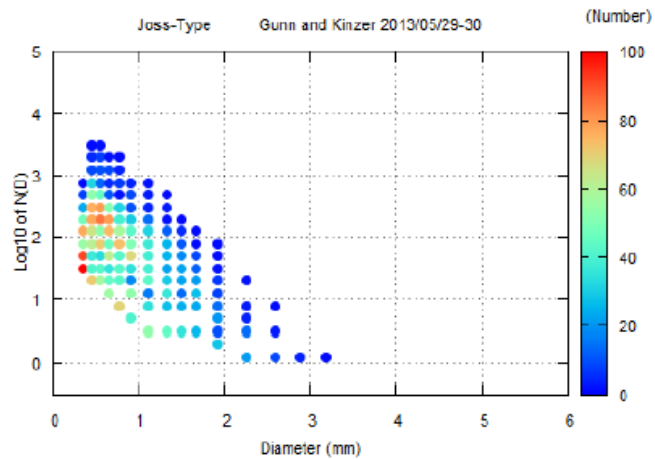
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At Pier (1) Mutsu, May 2013



At Pier (1) Mutsu, May 2013



At Pier (2) Mutsu, Oct. 2013

