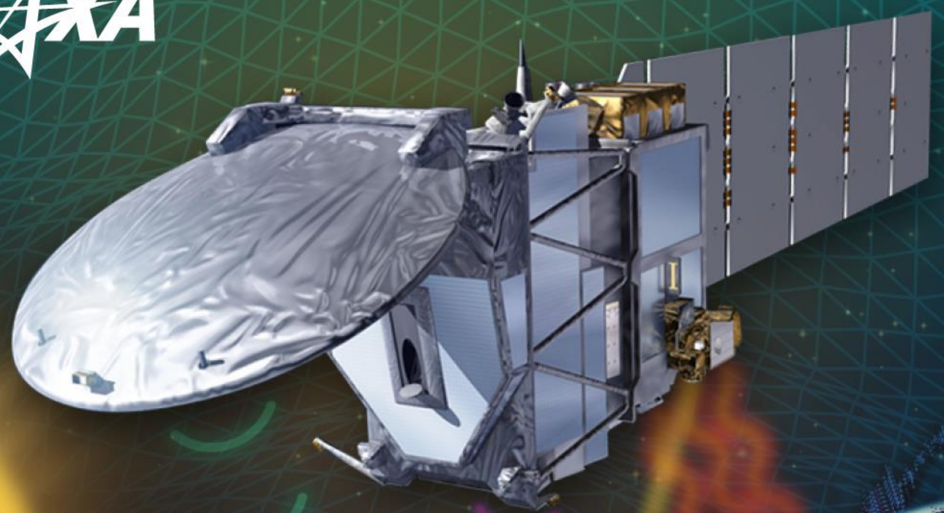

ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

13 – 17 November 2023 | ESA-ESRIN, Frascati (Rome), Italy

Validation Plan for EarthCARE/CPR Using Scanning Ka-Band Cloud Radar

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JAXA AOID 7: EarthCARE validation dataset created using ground based Ka-band radar and microwave radiometer observations

Overview of validation plan

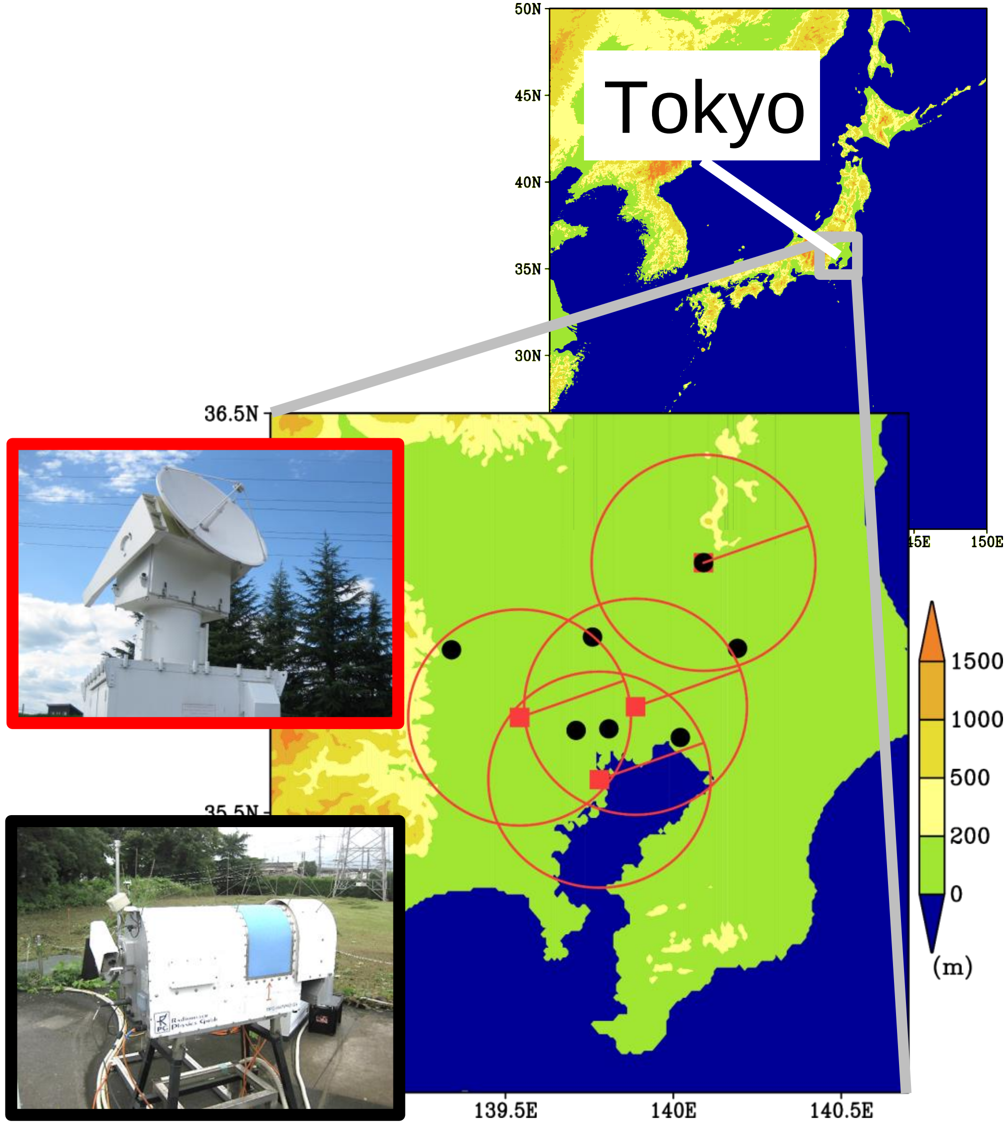
We are planning validation of the EarthCARE, mainly CPR (W-band (94 GHz) radar), using the ground-based Ka-band (35 GHz) radars and microwave radiometers (MWR) of the National Research Institute for Earth Science and Disaster Resilience (NIED).

1. statistical (climatological) comparison

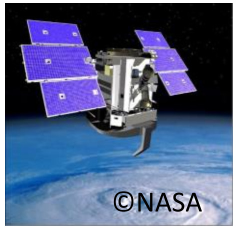
Since the frequency of observation of the same point (area) of EarthCARE is small, we plan to create a data set for statistical (climatological) comparison.

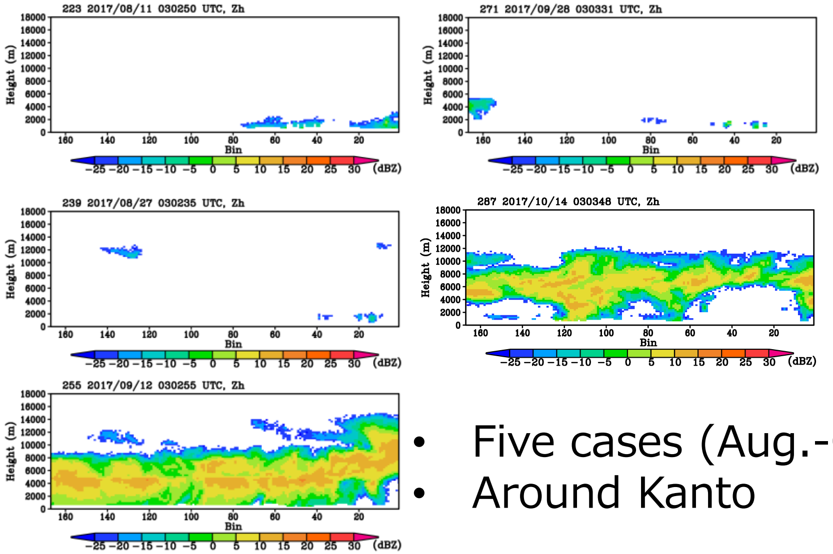
2. direct (simultaneous and same location) comparison

Using scanning capability of the cloud radars, simultaneous and same location comparison are also planned.



Statistical comparison
(climatological comparison using CFAD)

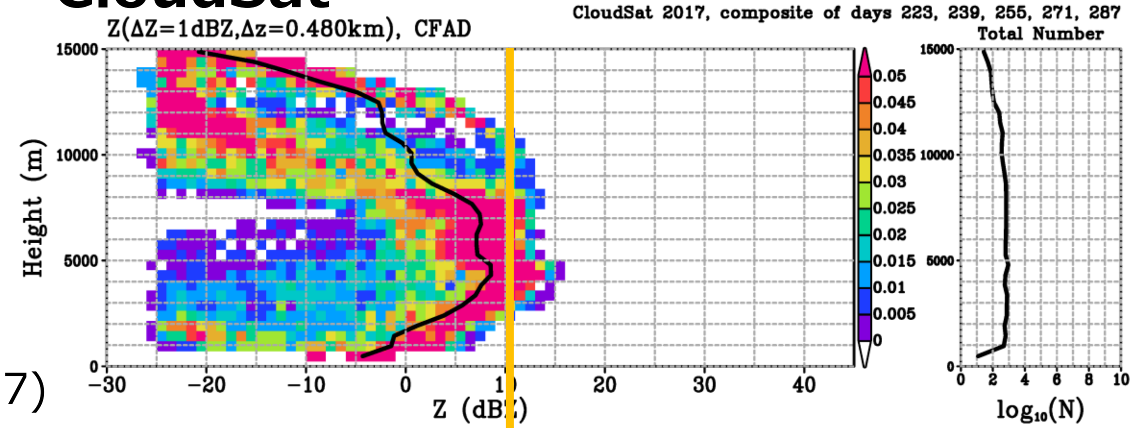




- Five cases (Aug.-Oct. 2017)
- Around Kanto

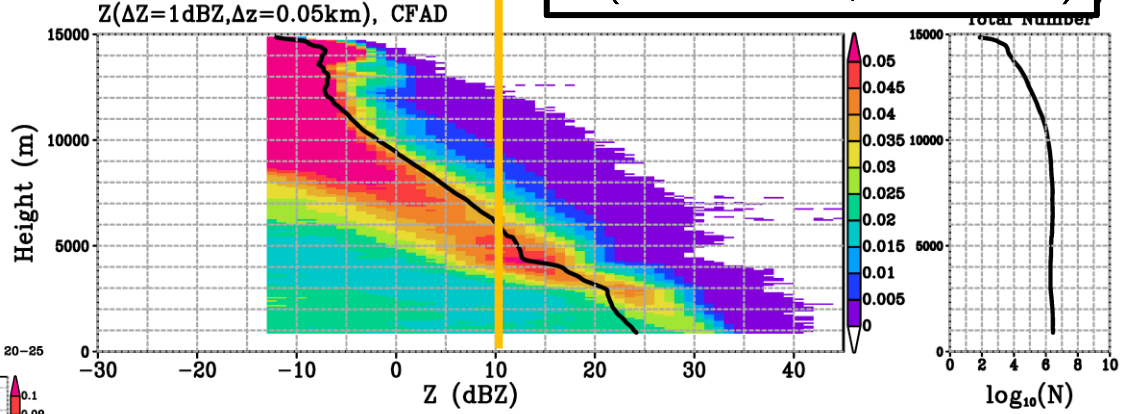
- 1 month (Oct. 2019)
- Ka1 (Tsukuba)
- 90°-PPI every 3 minutes

CloudSat

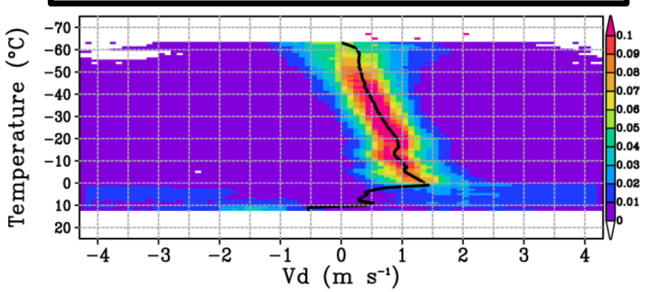


Ka-band Radar

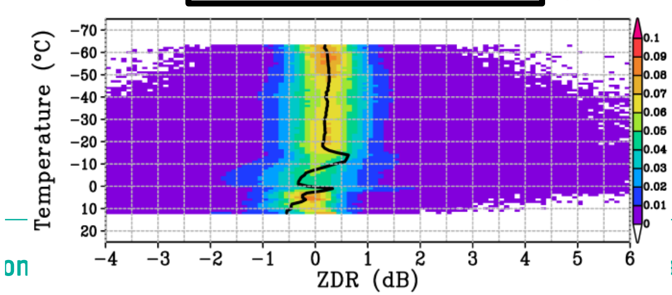
Z (vertical obs., Z>-13dBZ)



Doppler velocity
(vertical obs., Z>-13 dBZ)

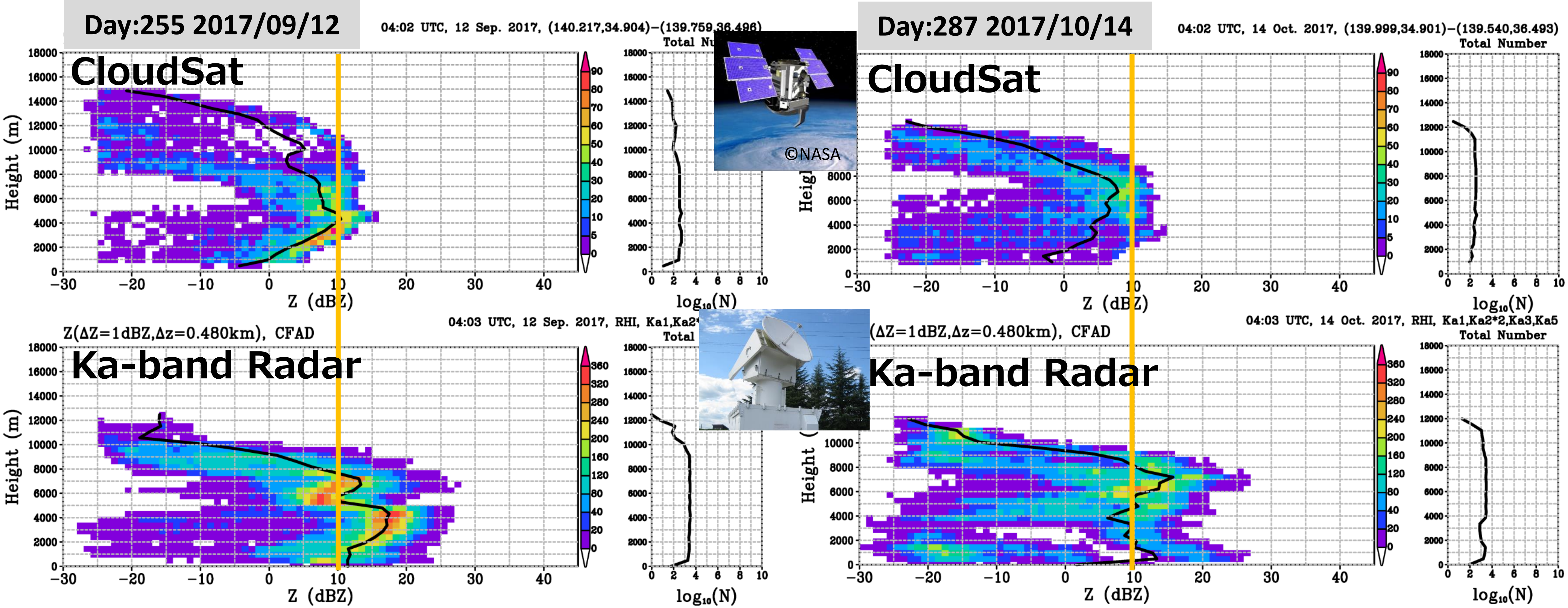


ZDR
(RHI, Z>-9dB)



- CloudSat (EarthCARE) samples are small and will be needed more samples (extension of range and period).

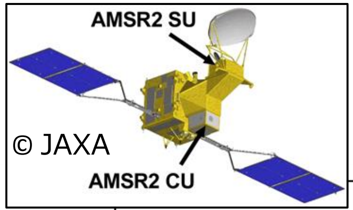
Statistical comparison
(case study using CFAD, quasi-simultaneous comparison)

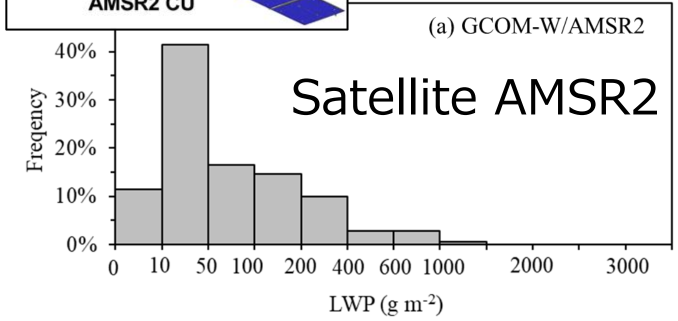


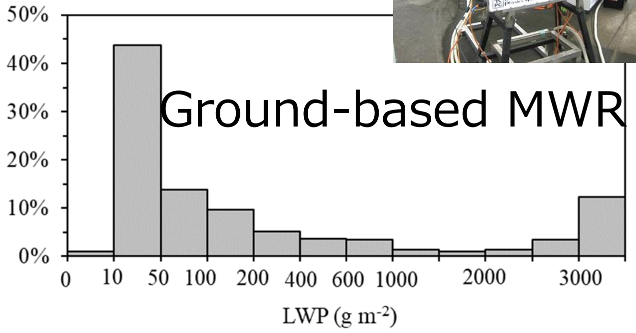
- Roughly speaking, CloudSat's and Ka-band radars' Z agree well, in the upper levels.
- At Z>～10 dBZ, differences are large. This may be the same reason as point-by-point comparison (non-Rayleigh scattering of CloudSat W-band radar).
- In the lowest levels, attenuation may cause some differences.

LWP of MWR
LWC estimated using MWR and Ka-band radar

Comparison of LWP

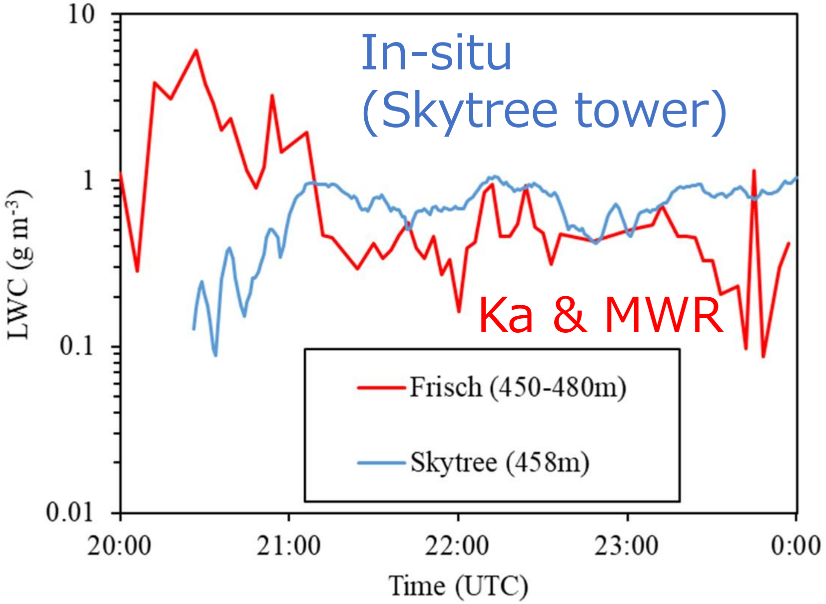






- Ground-based MWR liquid water path (LWP) is reasonable for a certain range (10-1000 g m^{-2}) when compared to satellite.

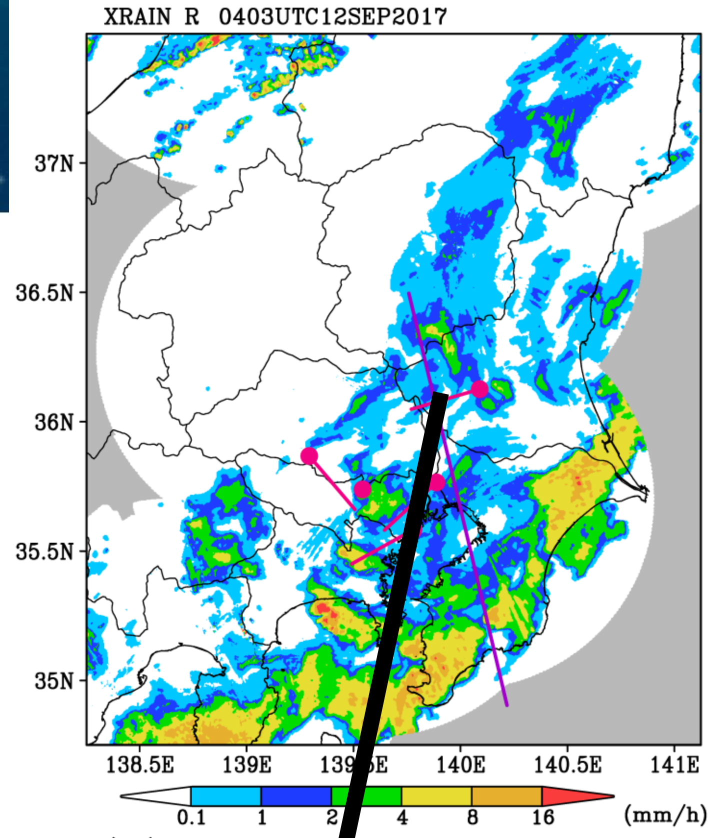
Comparison of LWC using MWR LWP

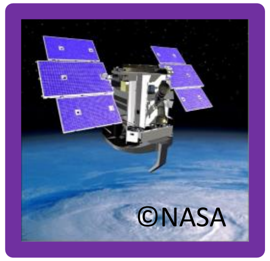


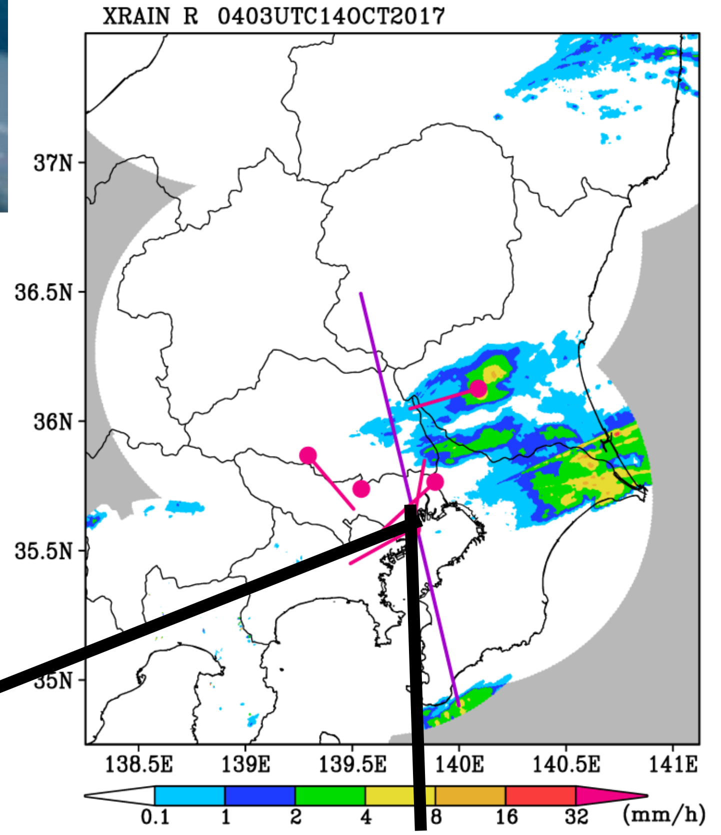
- We are developing estimation method of LWC, using MWR LWP and Ka-band radar reflectivity.

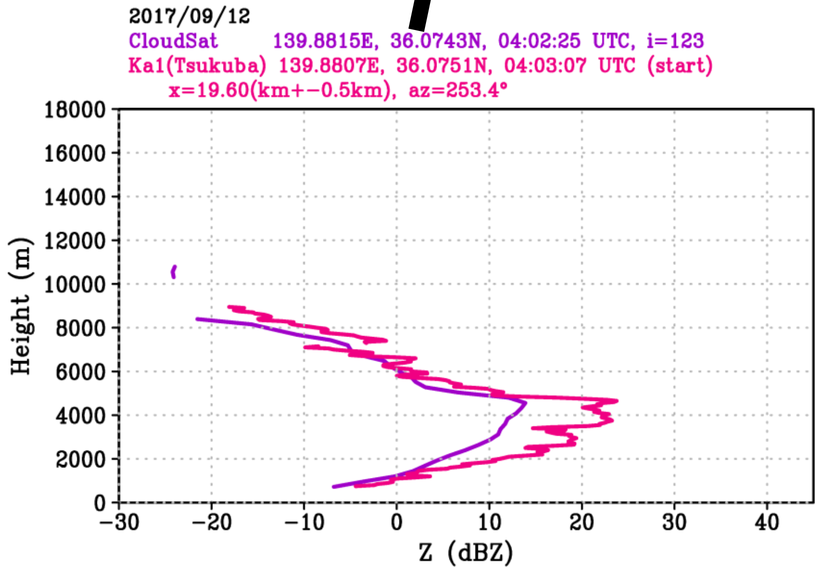
Point-by-point comparison (simultaneous, same point)

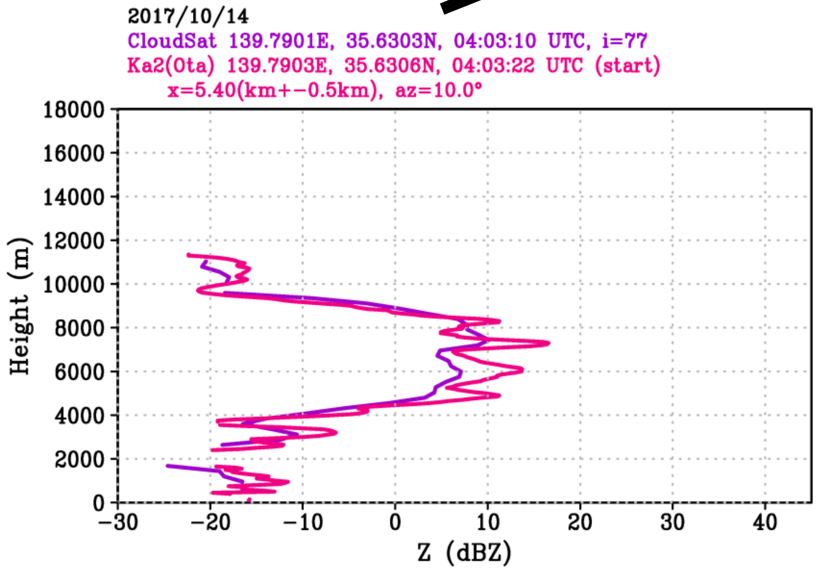
- Roughly speaking, CloudSat's and Ka-band radars' Z agree well.
- At Z>～10 dBZ, differences are large. This may be due to non-Rayleigh scattering of CloudSat W-band radar.

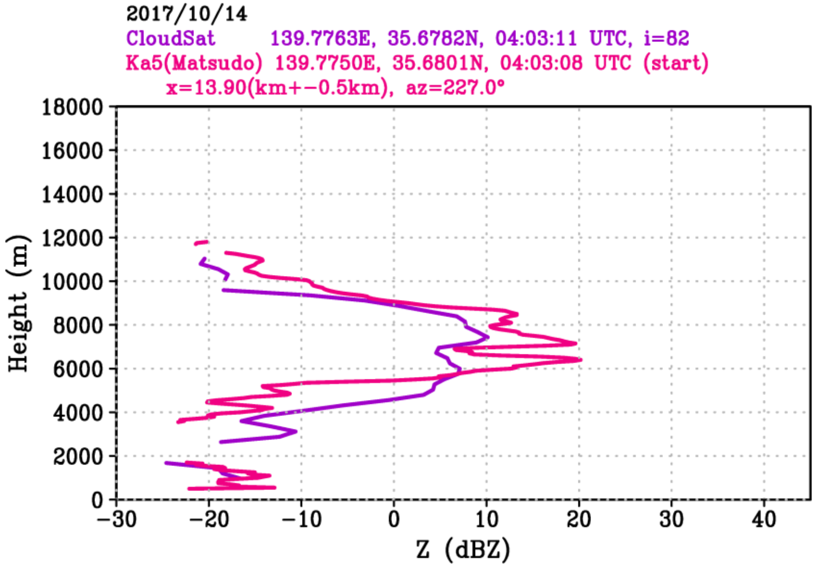






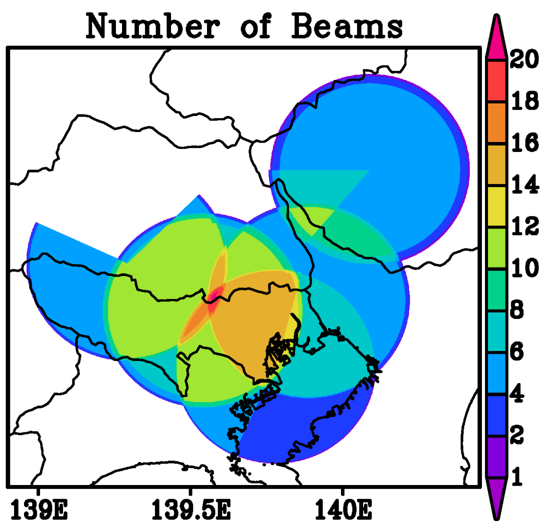




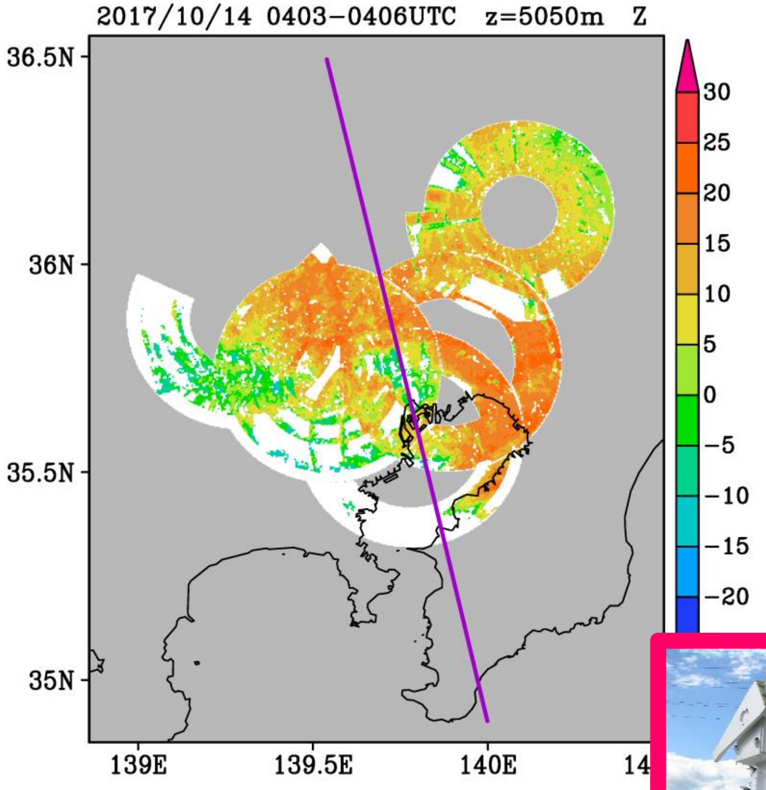


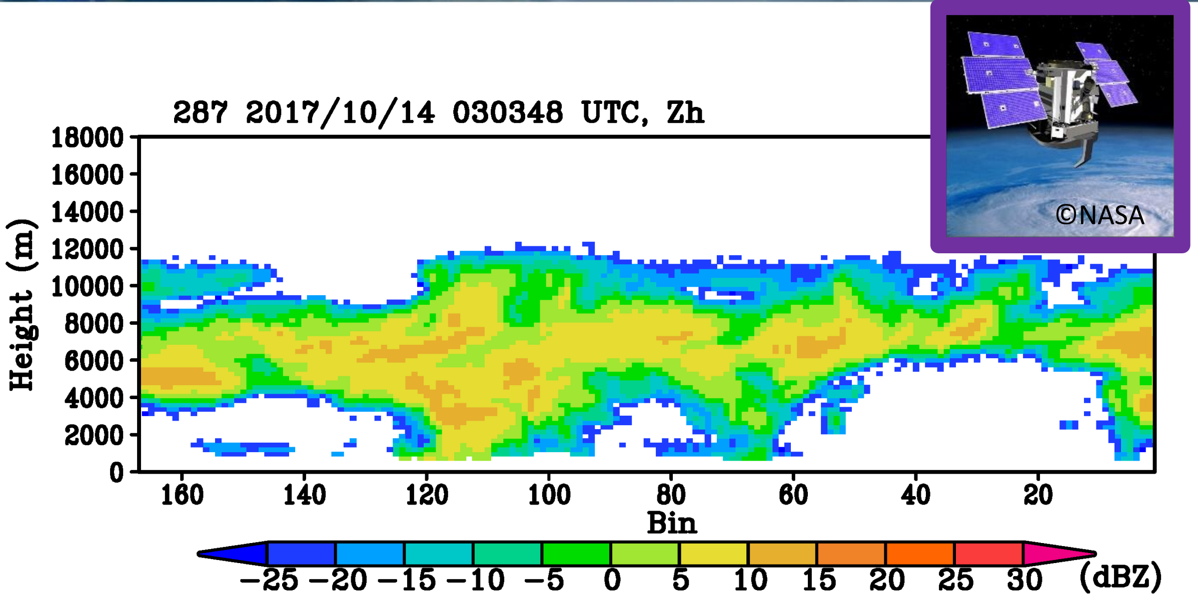
Comparison using vertical cross section created from a CAPPI of Ka-band radar

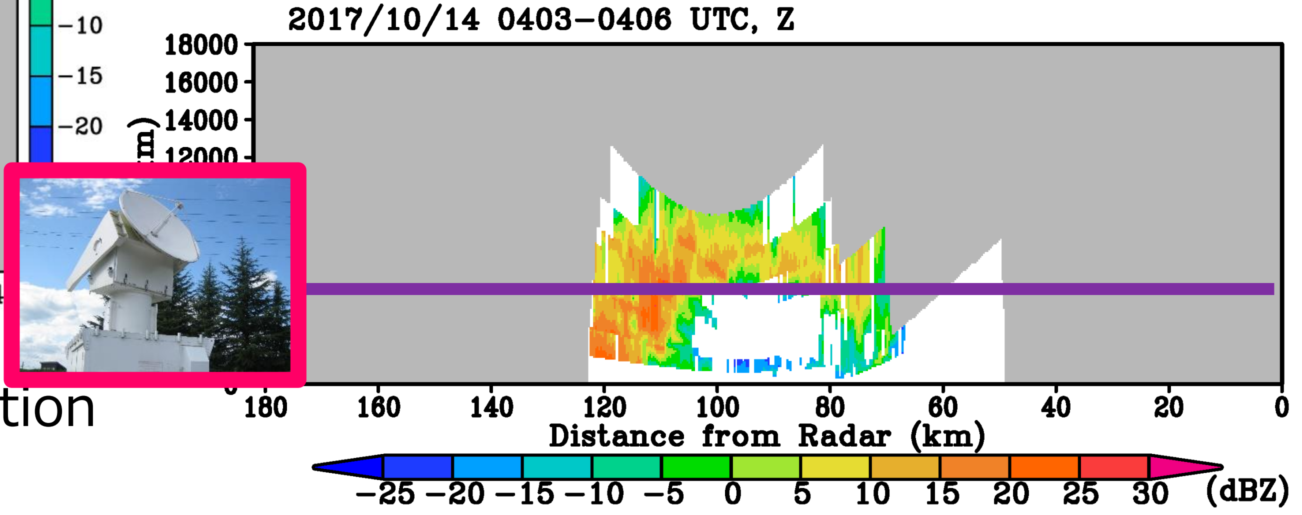
Number of elevation angles



CAPPI at 5050 m







- Scans with a sufficiently number of elevation angles will be required for comparison.

Summary of comparison methods between EarthCARE and ground-based observations

Method	Detail	Advantages and disadvantages
statistical	climatological histogram/CFAD/CFTD	＋Can be compared even in different years. －Need enough satellite samples.
	case study histogram/CFAD/CFTD	＋Almost no time lag. －Larger errors in spatially non-uniform clouds.
direct (only Z)	point-by-point	＋Almost no time and space lag. －Few chances.
	cross section of CAPPI	＋Almost no time and space lag. －Few chances. Coarse vertical resolution.