

X-band Polarimetric Radar Networks in Urban Areas

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Outline of X-NET

To mitigate urban disasters caused by severe storms, the National Research Institute for Earth Science and Disaster Prevention (NIED) has been implementing an advanced X-band radar network named X-NET since 2006. Research radars comprising the X-NET are 5 polarimetric Doppler radars and 3 Doppler radars. The goals of X-NET are to develop real-time processing of networked radar data and to provide end users high-resolution precipitation and wind data that are necessary to understand the mechanism of severe storms developments, improve its forecasting accuracy, and develop warning systems for urban disasters.

Observation Area

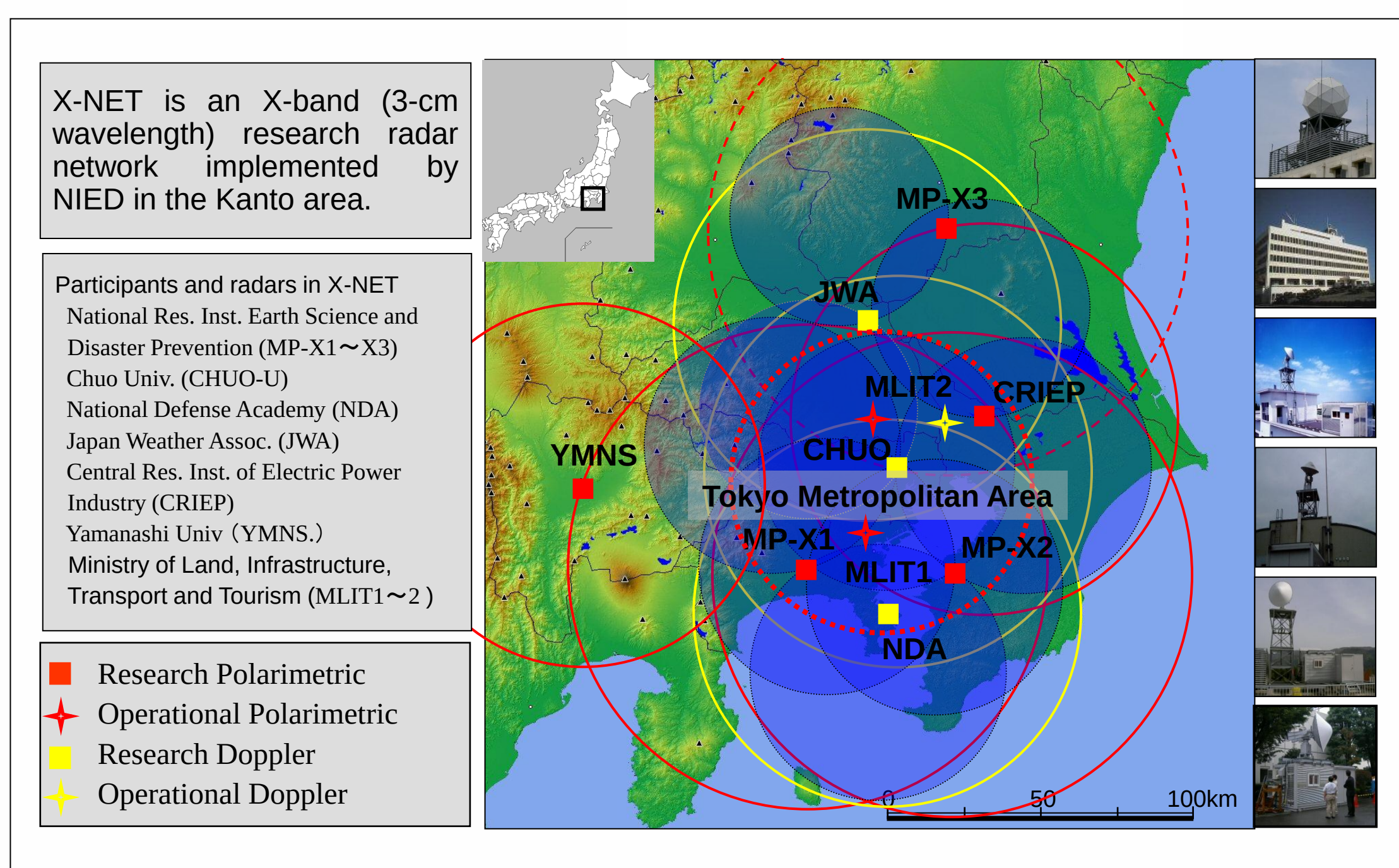


Fig. 1 Radar observation area and topography. MP-X is the code name of an NIED X-band polarimetric radar.

Data Level of X-NET Products

Table 1 Data level of the X-NET products

Data level	Description	Format (Coordinate)	Example
LEVEL 0	Raw radar data	system dependent (usually polar)	T, Z, V, W (for conv. radar)
LEVEL 1	Raw radar data	NetCDF (polar)	Z _{DBZ} , ρ _{DBZ} , Φ _{DBZ} , K _{DP} (for pol. Radar)
LEVEL 1.5	Raw radar data after quality control	NetCDF (geographic)	ditto
LEVEL 2	2p Two dimensional "basic" meteorol. Products	ditto	R, M, (u, v, w)
	2v Three dimensional "basic" meteorol. products	ditto	ditto
LEVEL 3	3p Two dimensional "advanced" meteorol. products	ditto	AR, CR, ER, VIL, HT, DSD, (u, v) _a
	3v Three dimensional "advanced" meteorol. products	ditto	HT, DSD, (u, v, w) _a
LEVEL 4	4p Two dimensional "forecasted" meteorol. products	ditto	R, M, AR, CR, ER, VIL, SW
	4v Three dimensional "forecasted" meteorol. Products	ditto	R, M, (u, v, w)
SUPLINE NTAL	CRSS Outputs from Cloud Resolving Storm Simulator	ditto	Meteorological parameters
	JMA Operational weather information from JMA	ditto	Radar, Objective Analysis, MSN outputs

R: rain rate, M: rain water content, (u, v, w): wind vector, (u, v, w)_a: assimilated wind vector, AR: areal rainfall, CR: cumulative rainfall, ER: effective rainfall, VIL: vertically integrated liquid water, HT: hydrometeor type, DSD: drop size distribution, SW: strong wind area

QPE Algorithm of X-NET

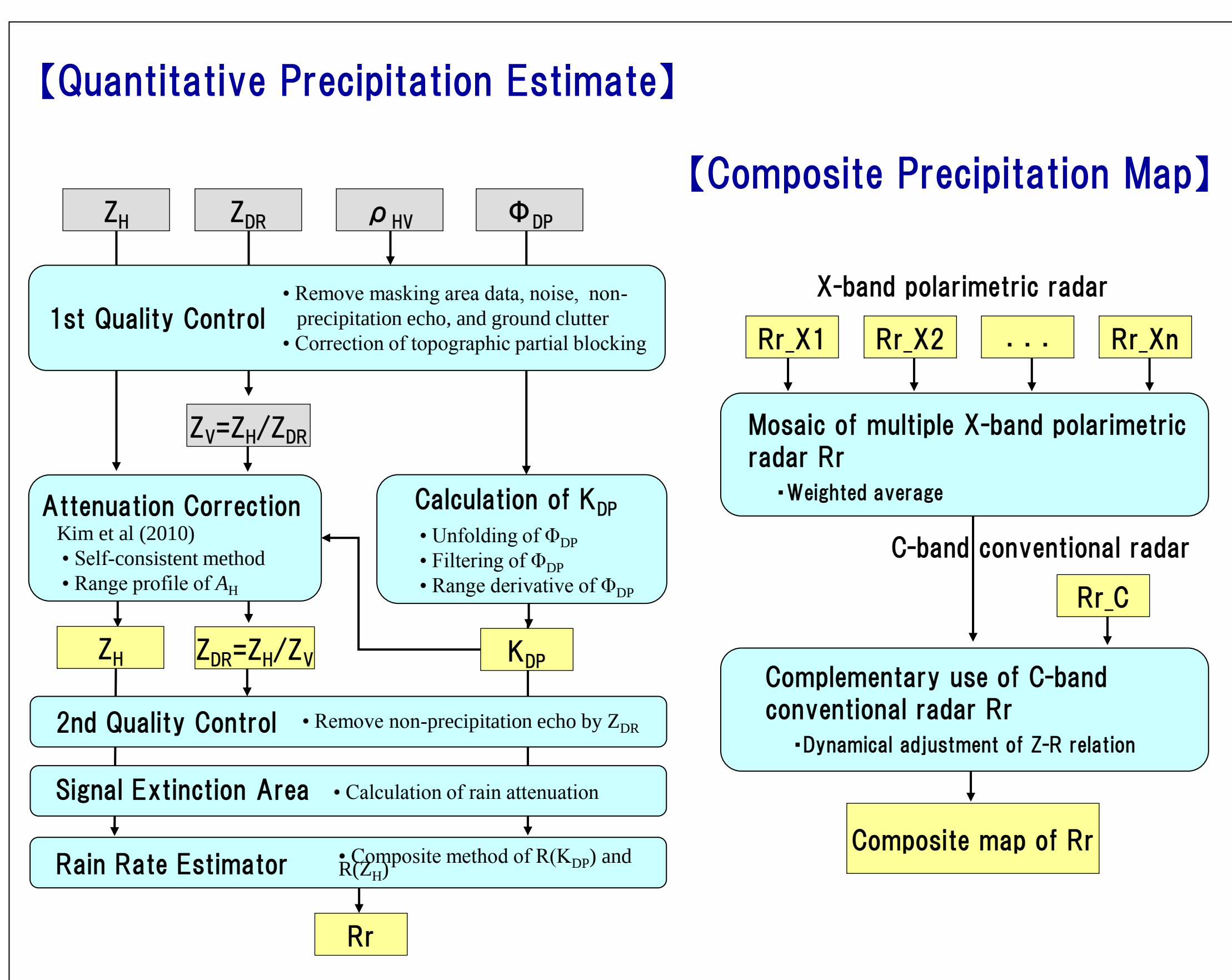


Fig. 2 Flowchart of the QPE procedure employed by the X-NET.

Examples of QPE Products

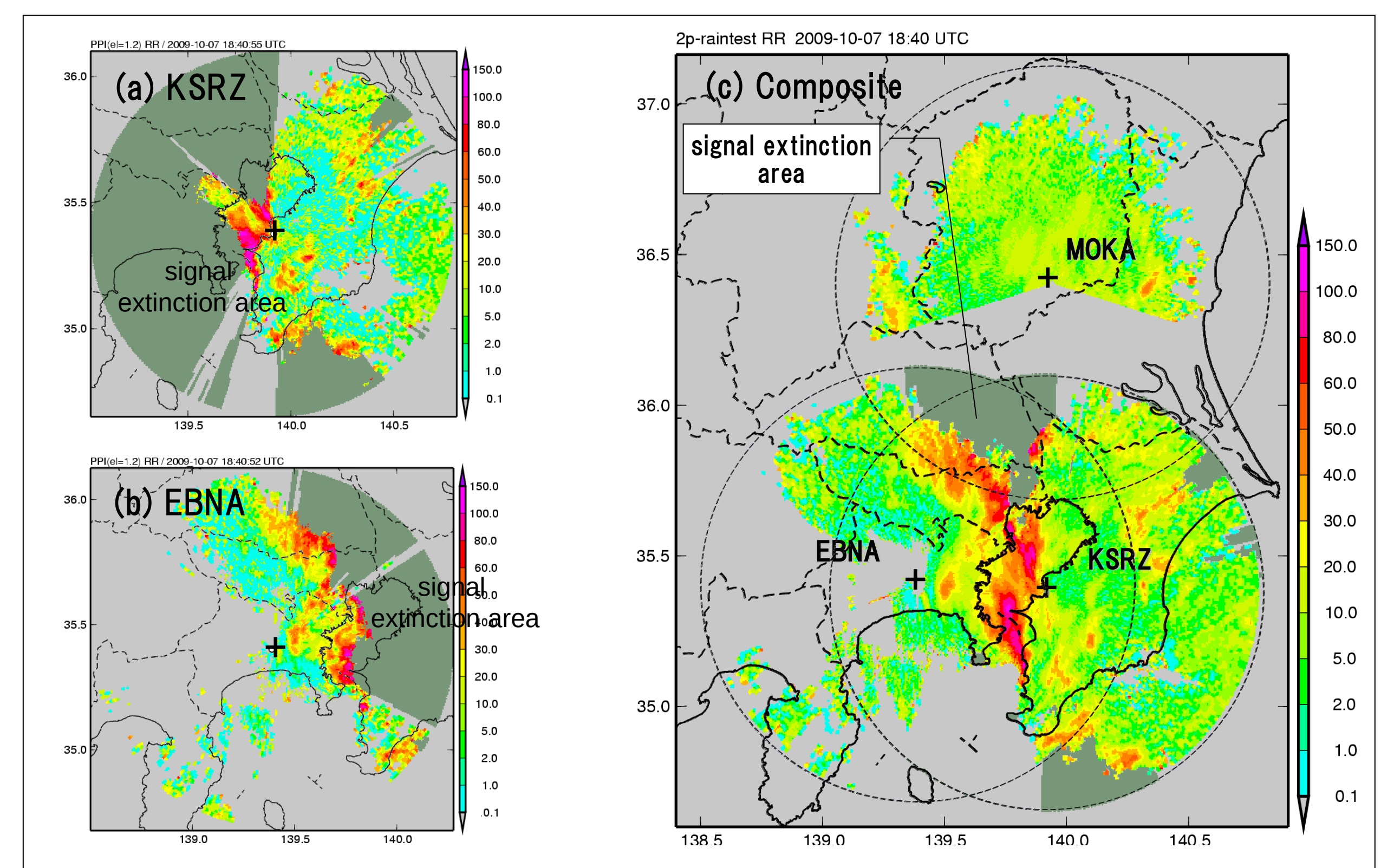


Fig. 3 An example of composite of rainfall distribution by three NIED polarimetric radars. (a) Kisarazu radar (KSRZ), (b) Ebina radar (EBNA), and (c) Composite. 18:40UTC, October 7, 2009.

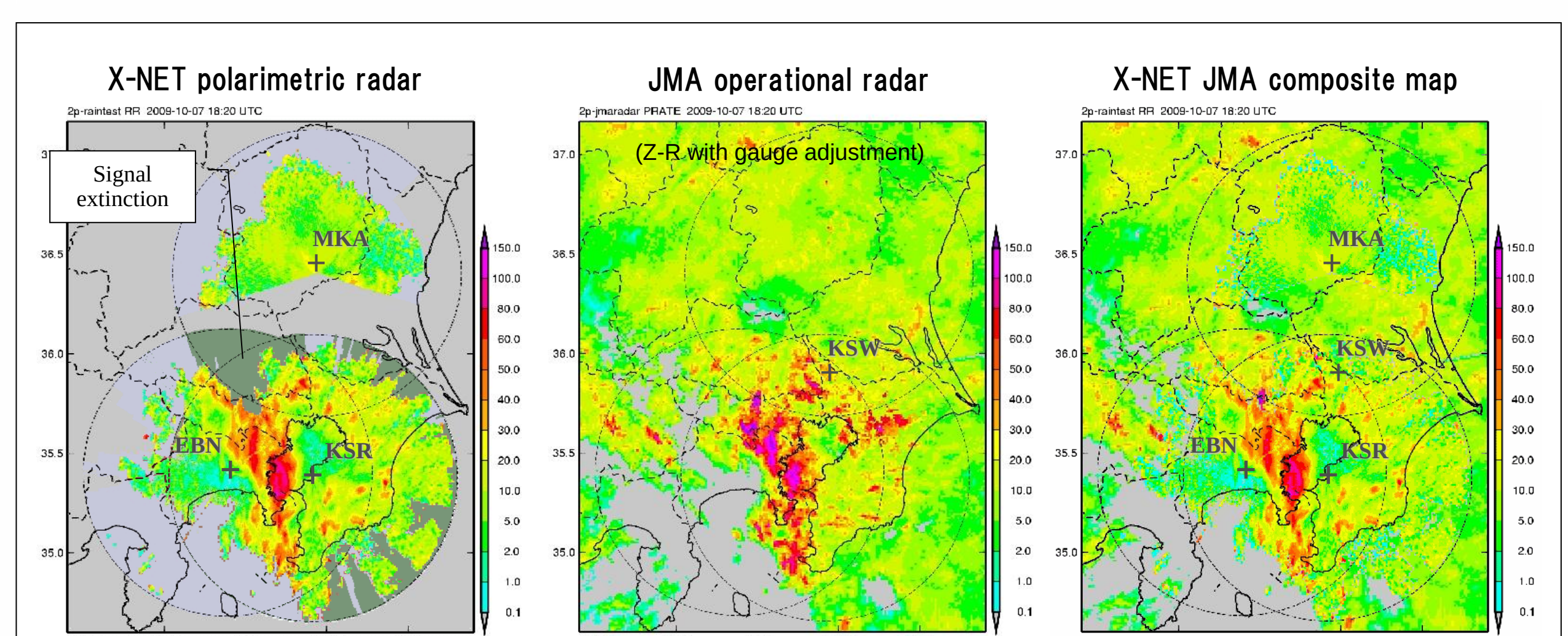


Fig. 4 An example of composite map of X-band polarimetric radar network data and C-band conventional radar data.

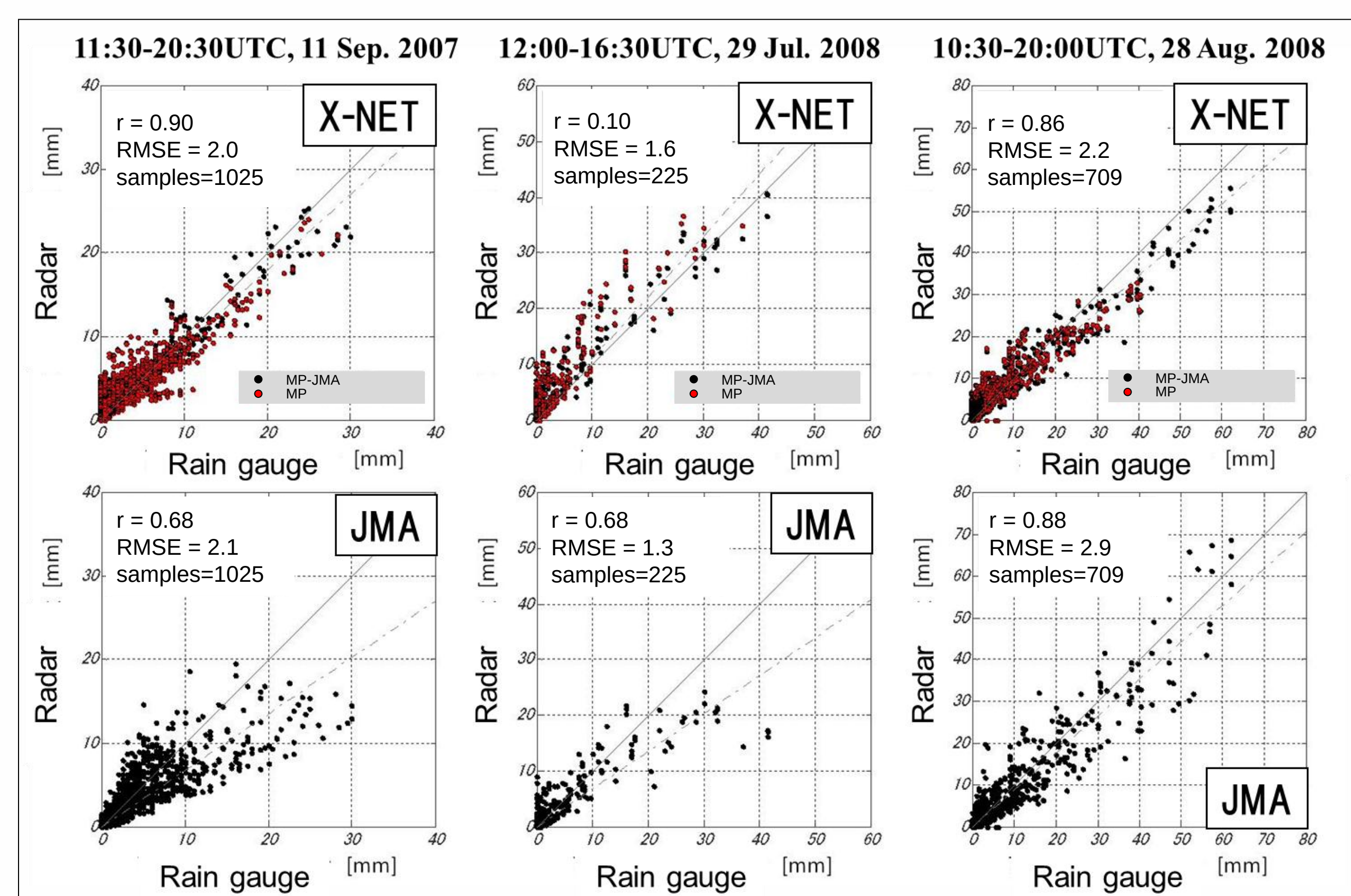


Fig. 5 Comparisons of one hour X-band polarimetric radar rainfall estimates with surface rain gauge data (Kato et al., 2009).

Summary

- Algorithms of quantitative precipitation estimate (QPE) of the research X-band polarimetric radar network named X-NET are presented. The QPE is based on the K_{DP} -R relationship for moderate to strong rainfall and the Z-R relationship for weak rainfall.
- Signal extinction caused by heavy rainfall attenuation, which is one of disadvantages of X-band radar, can be overcome by radar networking and complementary use of an conventional C-band radar.
- The algorithms described here were adopted with some modifications in the operational X-band polarimetric radar network of the Ministry of Land, Infrastructure, Transportation and Tourism (MLIT), Japan. The MLIT radar networks have been tested since 2010 to monitor and nowcast localized heavy rainfalls which cause urban flooding.