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Estimation of Space-Time Structure of Raindrop Size Distribution at Heavy Rainfall

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1. INTRODUCTION

In Japan, test operating of X-band polarimetric radar network with a quite high density started in July, 2010 by Ministry of Land, Infrastructure, Transportation and Tourism (MILT) as shown in Fig. 1. Polarimetric radar has an advantage over conventional non-polarimetric systems because they measure some parameters related to raindrop shape. In this study, a retrieval method of raindrop size distribution (DSD) is developed to improve accuracy of rainfall estimation. Also, DSD is helpful to understand the mechanism of cloud dynamics and microphysics.

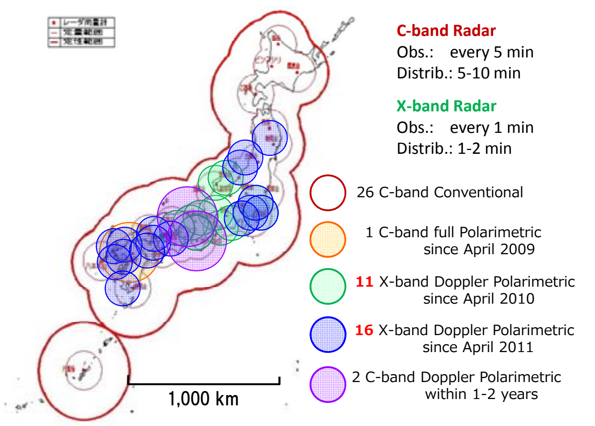

Fig. 1 Current radar network in Japan.

2. A NEW ESTIMATION ALGORISM OF DSD PARAMETERS USING KDP

The estimation accuracy of D_0 is not good at heavy rain using previous method. A new method uses specific differential propagation phase shift (KDP), since KDP is insensitive to rain attenuation which happens at heavy rainfalls, comparing that differential reflectivity (ZDR) has some observational noises as shown in Fig. 2.

However, as KDP does not have a good relationship with DSD parameters compared with ZDR, in this study, KDP/Nw is used for the DSD estimation, where Nw is one of DSD parameters and Nw means the number concentration of raindrops. KDP/Nw would be a creative parameter in Fig. 3, Fig.4. The new developed DSD retrieving method was superior then previous method when heavy rainfall occurs as shown in Fig. 5.

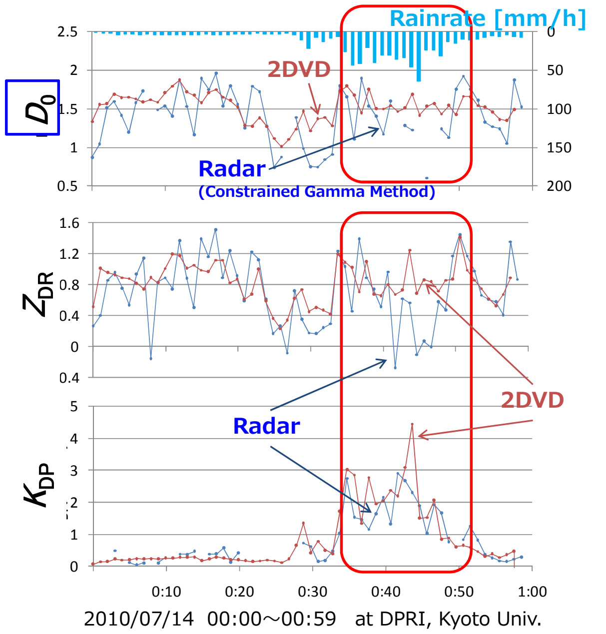

Fig. 2 D_0 estimation and Polarimetric parameters compared with 2-dimensional video disdrometer.

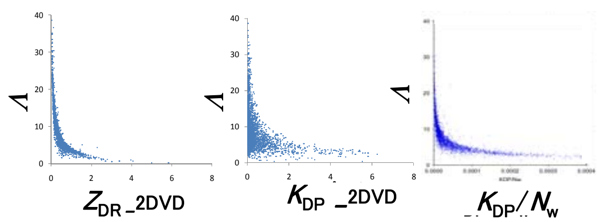

Fig. 3 The relationship between DSD parameter and Polarimetric parameters using 2-dimensional video disdrometer.

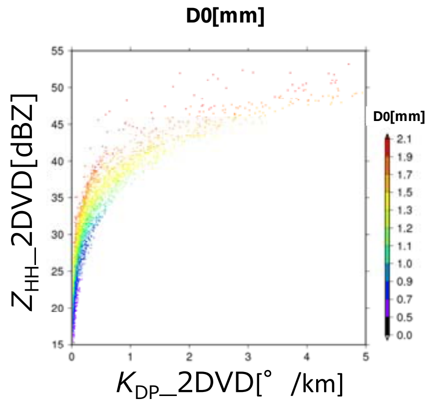

Fig. 4 A new algorism of estimation of D_0 by the combination of two Polarimetric parameters.

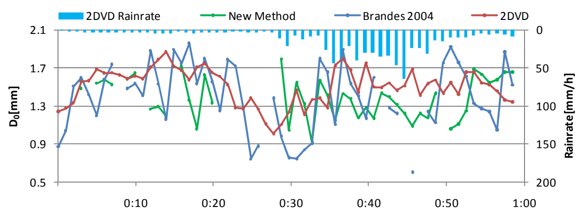

Fig. 5 Evaluation of new algorism of estimation of D_0.

3. DSD Estimation at a Convective Cloud

DSD information is helpful to understand the mechanism of cloud dynamics and microphysics. Our new method is applied to a convective cloud which occurred in Kyoto at July 7, 2010. As shown in Fig. 6, D_0 is big, and N_w is small at a "baby" rain cell at the height of 2 – 3 km. Also, both D_0 and N_w are big near surface.

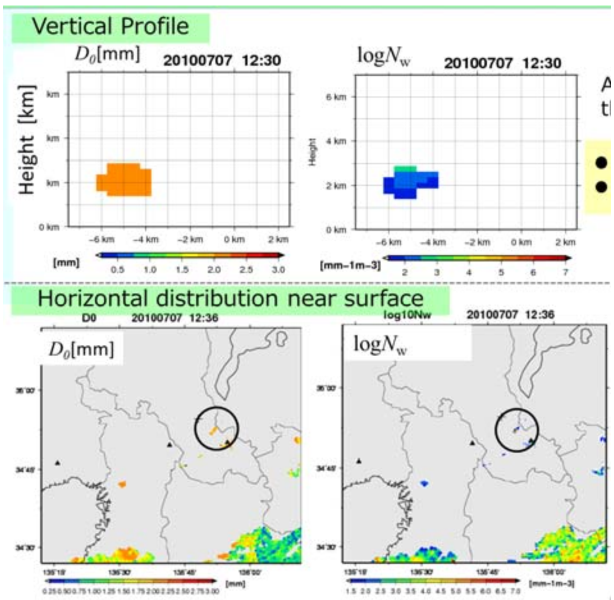

Fig. 6 DSD estimation at heavy rainfall case.

4. Quantitative Precipitation Estimation Using DSD Parameters

After retrieving DSD parameters, rain rate estimation for non-polarimetric radar is directly estimated from the retrieved DSD parameters. Two methods are used, the one of them is developed in this study in Fig.7. Both are evaluated using disdrometer, and it is shown that both are well estimated when compared with the previous studies in Fig. 8.

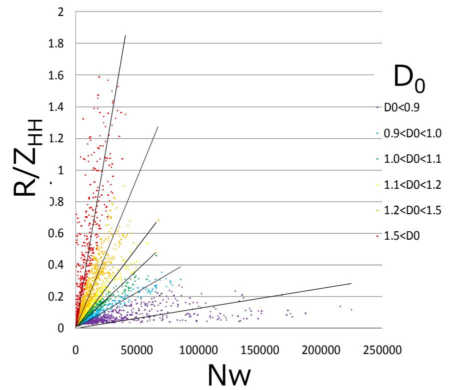

Fig. 7 A new algorism of QPE using DSD parameters.

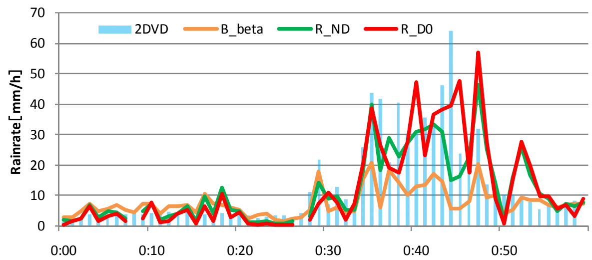

Fig. 8 A time series of rainrate compared with the ground raingauge.

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