Study on the radar QPE based on observations of snowfall minimizing wind-induced errors

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Photo: 2014.01.13, SPOS Tokamachi site

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1. Introduction

- *The shape of solid and melting precipitation particles varies significantly, leading to the difficulty of the quantitative precipitation estimation (QPE) from ground and space-borne radars.*

- *To solve this problem, we conducted observations of precipitation particles, high-resolution precipitation intensity, and Ze and polarimetric radar parameters.*

- *The result of an analysis using two-winter data is briefly described in this presentation.*

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National Research Institute for Earth Science and Disaster Prevention

Observations

■ SCONE (Snowfall Campaign Observation in Niigata Experiment)

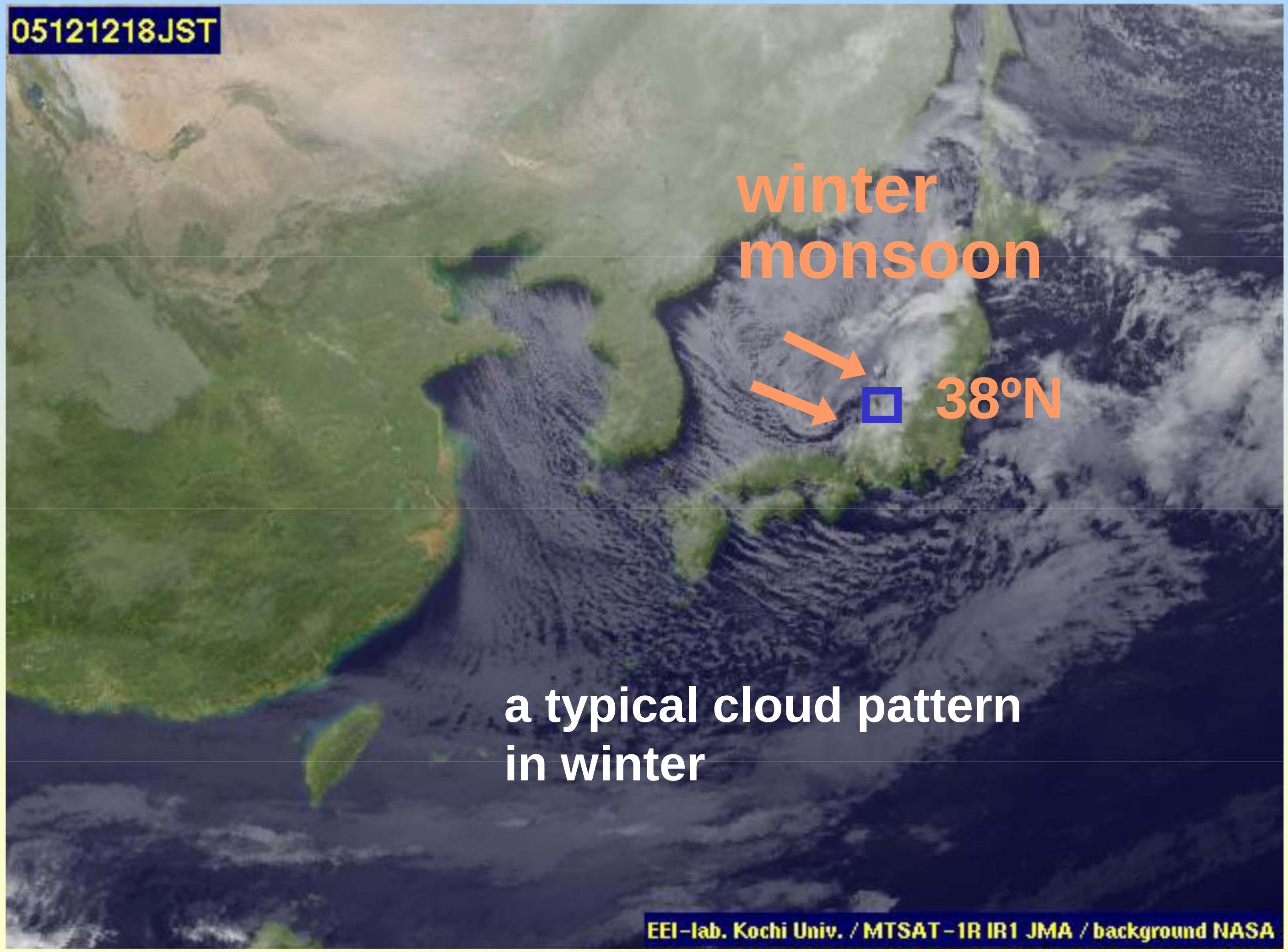
Facilitiy	RA6 (done)			RA7 PI206 (planned)		
	2010/2011	2011/2012	2012/2103	2013/2014	2014/2015	2015/2016
*X-POL	○	○	○	○	○	○
*FSO	○	○	○	○	○	○
#Surface	○	○	○	○	○	○
*SW-Net	○	○	○	○	○	○
SPOS	○	○	○	○	○	○
Rawinsonde		○	○			
Ka radar		○				
VertiX/2DVD			○			

* Products of NIED project "Research on advanced snow information and its application to disaster mitigation" were used.

\# Products of regular observations of HRC/NARO, FFPRI, and NIED were used.

Observations : Location of the observation field

- The field experiment is conducted in the Niigata region, a heavy snowfall area in Japan.



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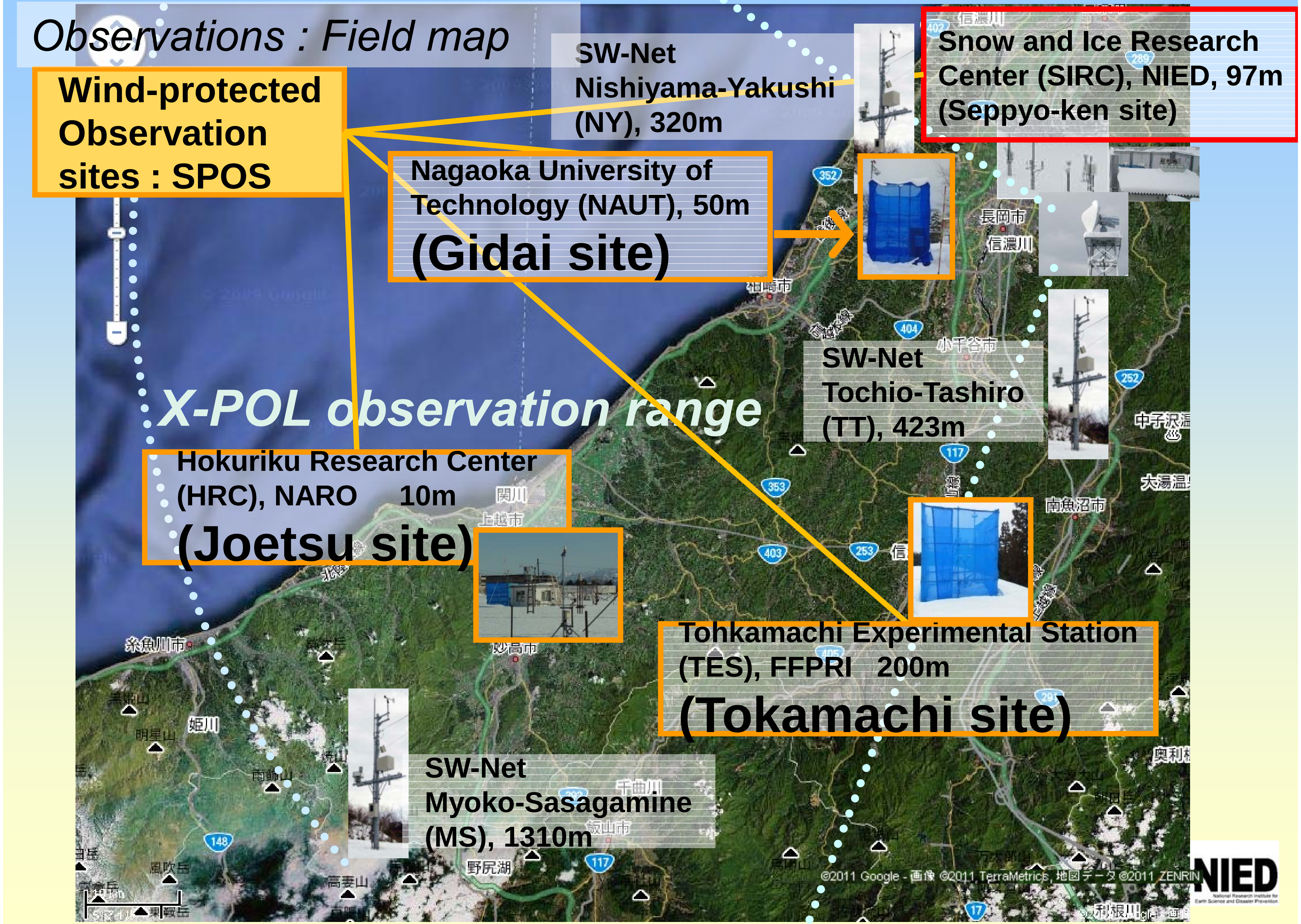
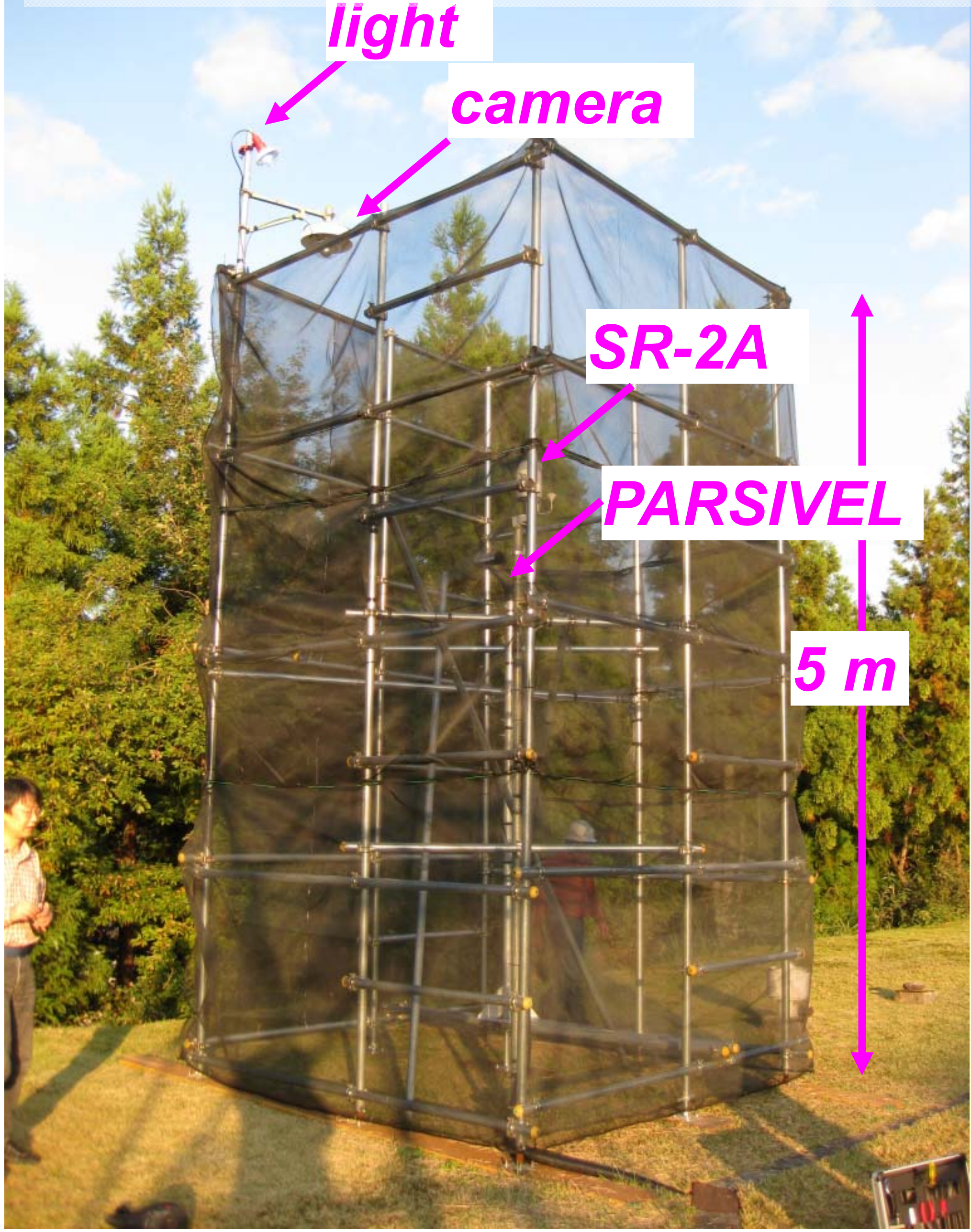
Observations : Field map



Snow Particle observations : SPOS



- *A Snow Particle Observation Station (SPOS) is composed of*

a PARSIVEL (OTT Hydromet GmbH),

an SR-2A (Tamura Seppyo Keisoku Laboratory),

a Web camera (Panasonic BB-HCM581),

an LED lamp, and

a wind shield fence.

Time resolution of PARSIVEL and SR-2A data is 1 minute.

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Data

- *Data : Three SPOS site data, X-POL PPI data (EL: 1.9deg), and AMeDAS temperature*
- *Period : November to March in 2010/2011 and 2011/2012 winters*
- *Sampling : 1-minute intervals (SPOS)*

  10-minute cycle (X-POL)
- *Analysis time resolution : 10 minutes*
- *#data : 15460 samples*

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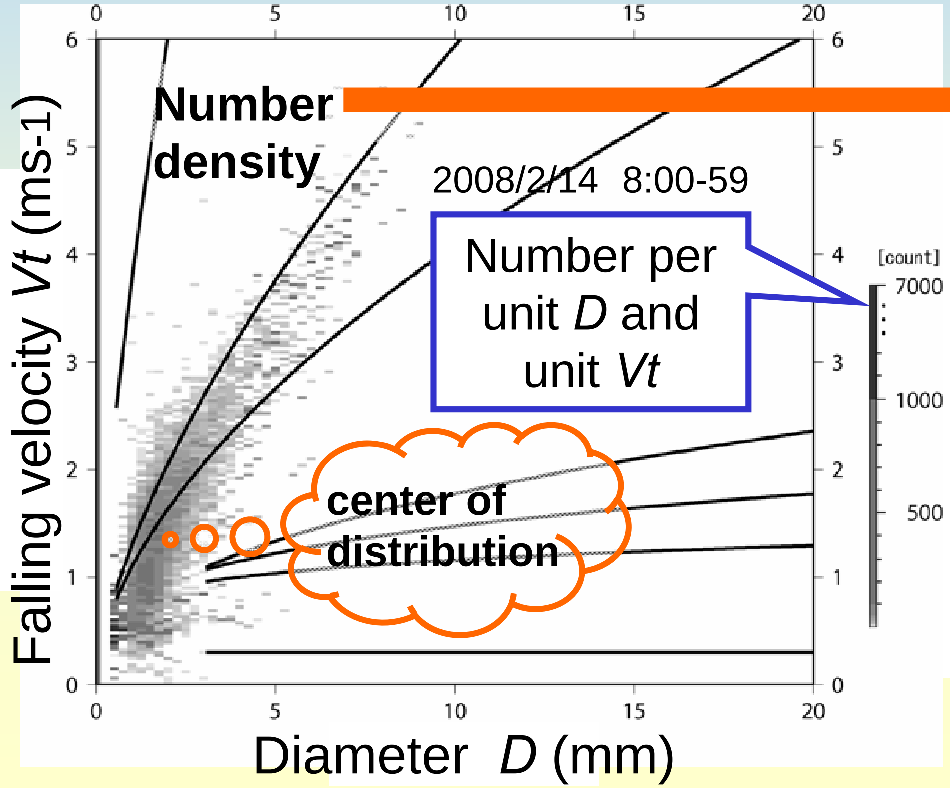
Method : Falling snow particle parameter, CMF

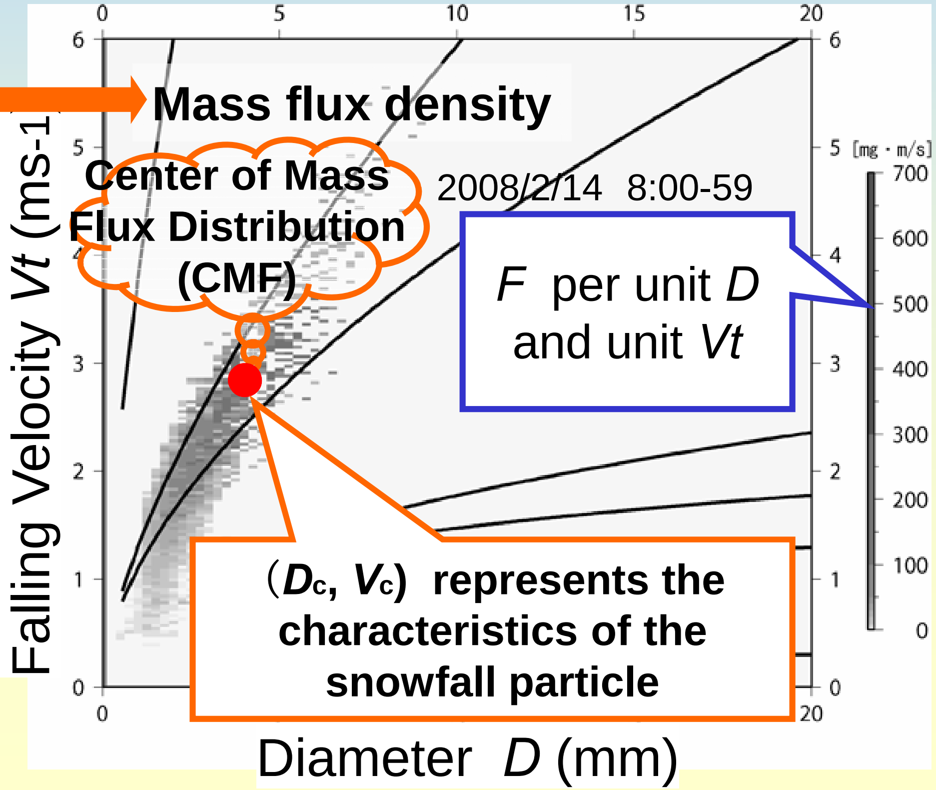
- A representative diameter Dc, and falling velocity Fc.

Using experimental functions of diameter (D) and kind (k) of snowfall particles,
mass : *m=f(k,D)* and
falling velocity : *Vt=f(k,D)* ,
number density was converted to vertical mass flux density, *F*.

Mean diameter D_c and falling velocity V_c both weighted by *F were calculated .*

Ishizaka et al. (2013, JMSJ)





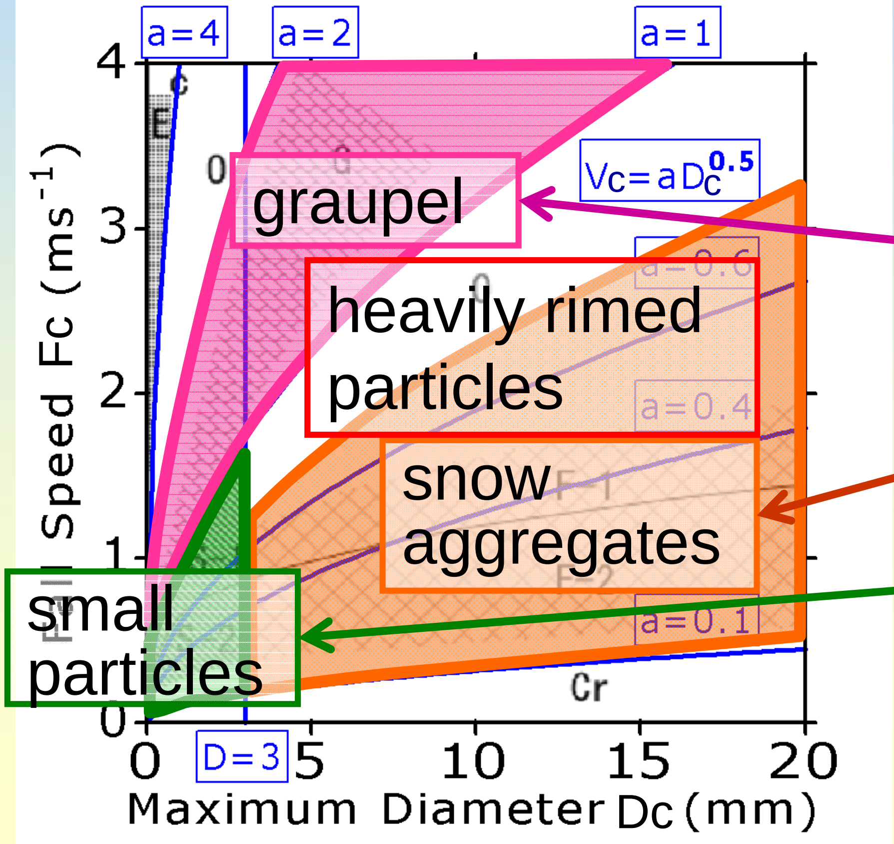
Method : Falling snow particle parameter, RMI

- Using mean diameter (Dc) and mean falling velocity (Vc), a parameter named Riming and Melting Index

  $RMI = Vc/Dc^{0.5}$

  is calculated.

Vt-D Diagram by Ishizaka et al. (2004)



- RMI, together with Dc, can be used to express simply the kind of snowfall particle.

(dry snow)

$1 \leq RMI < 2$
$\rightarrow$ graupel

$0.1 \leq RMI < 0.7$, $Dc \geq 3mm$
$\rightarrow$ aggregates

$0.1 \leq RMI < 1$, $Dc < 3mm$
$\rightarrow$ small particles

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Method : Relating Ze-R and RMI

- On Ze-R relation, $Ze=BR^{\beta}$, Rasmussen et al.(2003) showed that the exponent should be β=1.67. Then, the logarithmic form of this relation is

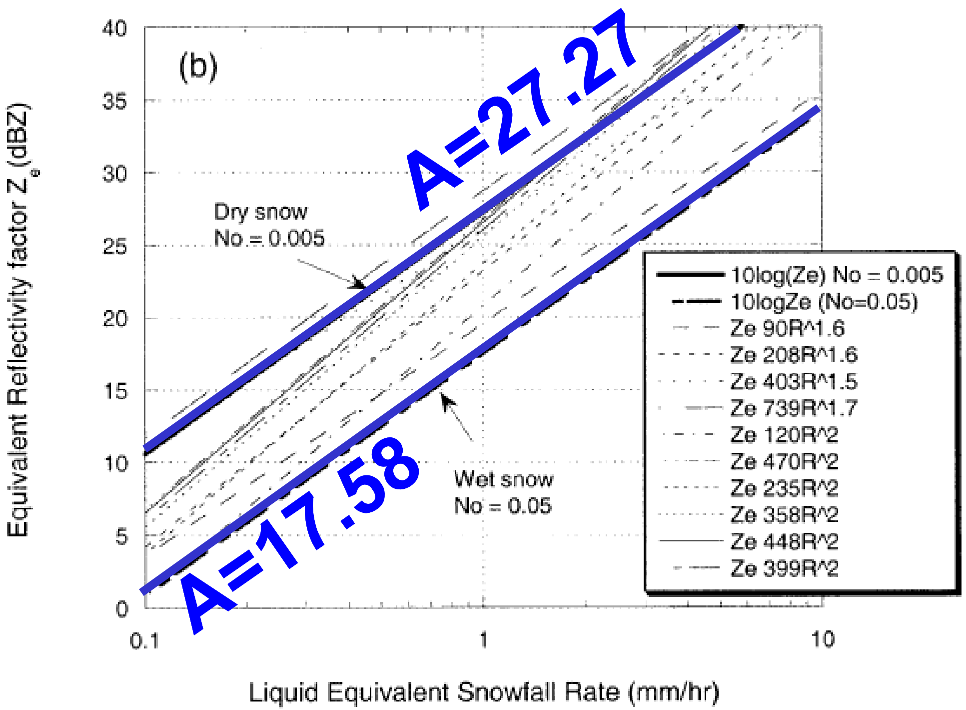
  $A=dB(Ze)-16.7\log(R)$ ($A=10 \times \log_{10}B$)

  Typical A values are

  17.58(wet/rimed snow with large N_0)

  27.27(dry snow with small N_0)

N_0 : y-intercept of the size distribution



Rasmussen et al.(2003) Fig. 2

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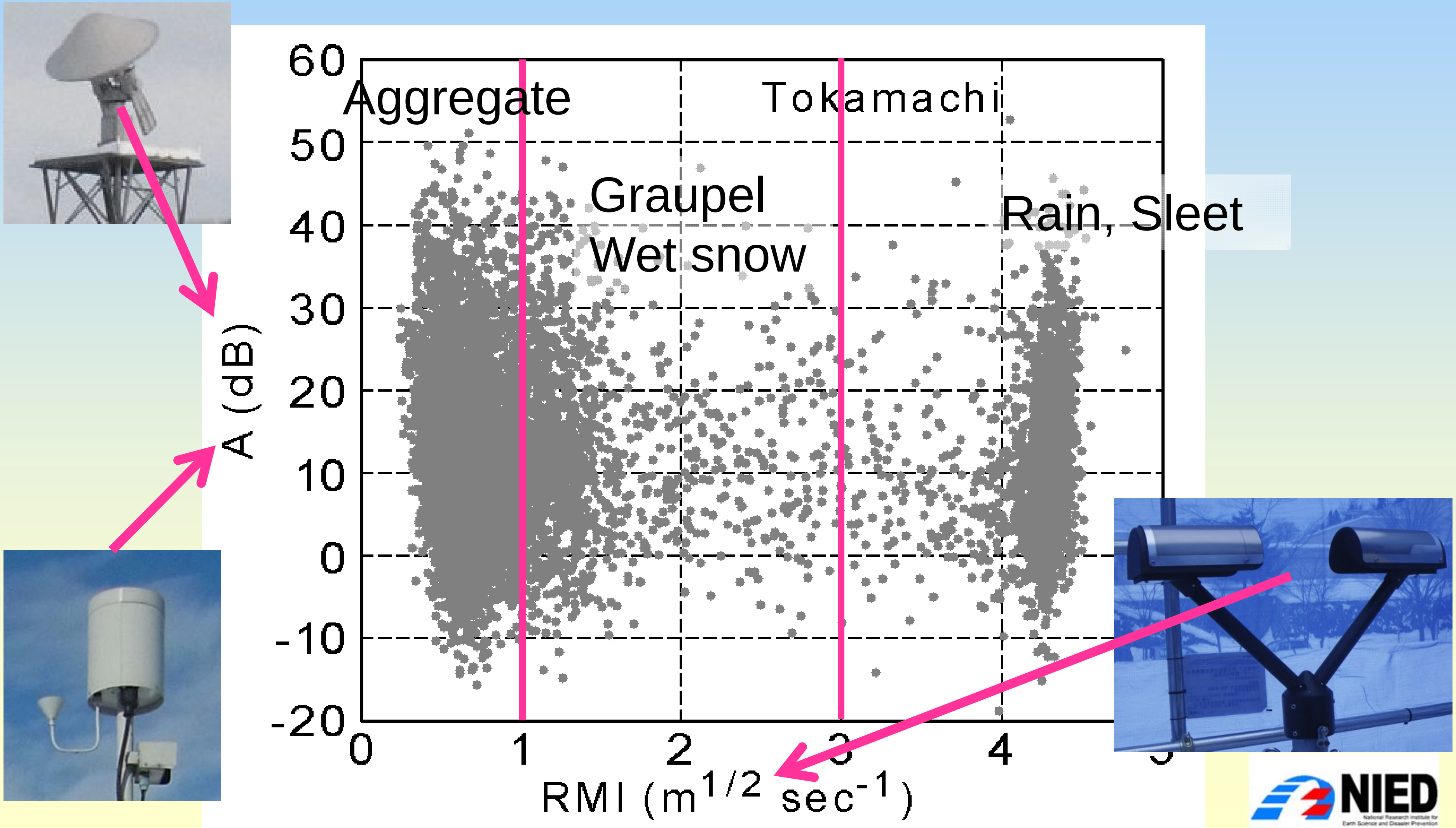
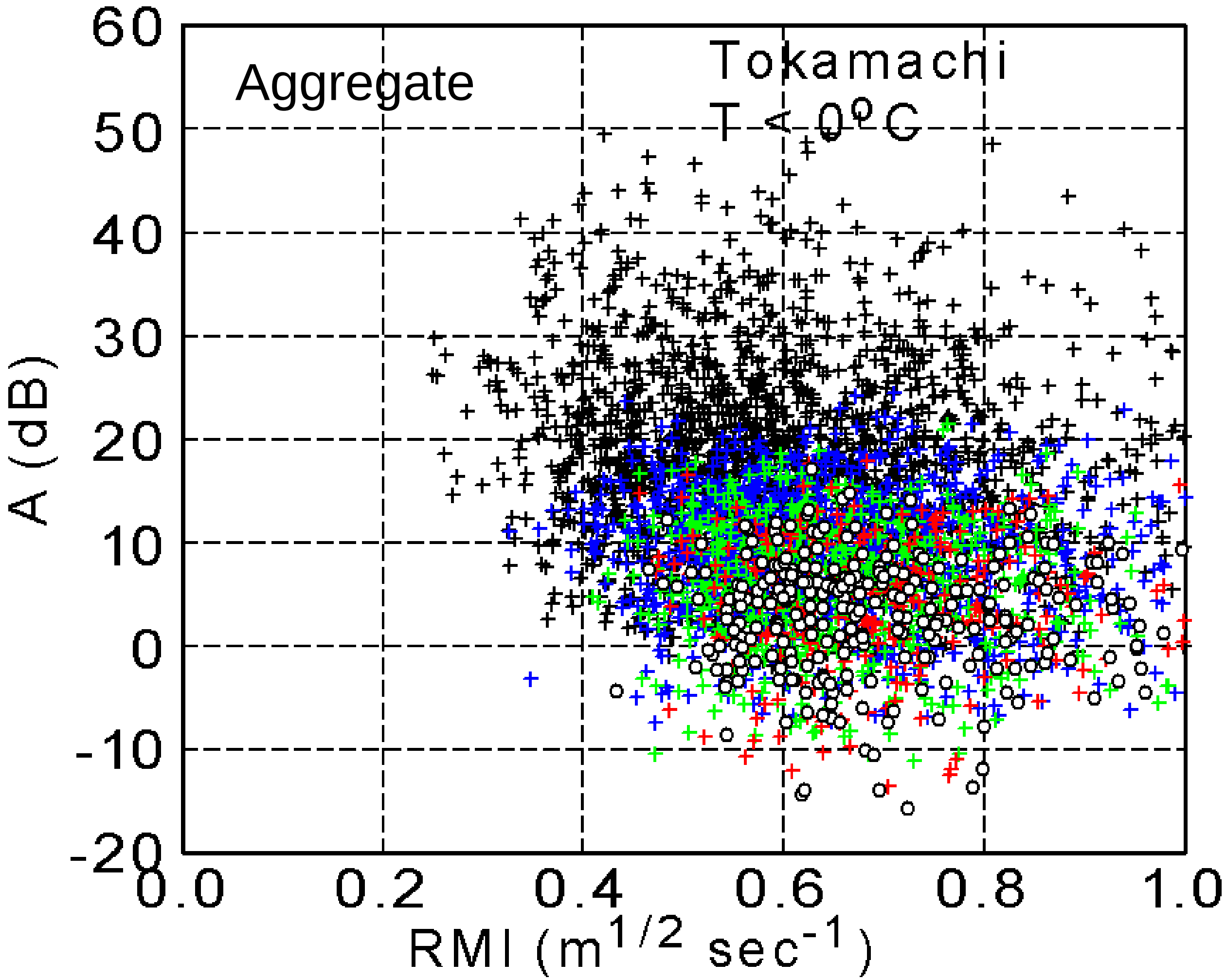
Result

- *A* (=10 x $\log_{10}B$) plotted versus RMI. *A* is derived from radar and SR-2A data, and RMI is derived from Parsivel data.



Result

- As for aggregates, A and RMI seemed to have a negative correlation. A was smaller and the precipitation intensity was larger when the degree of riming indicated by RMI was larger.

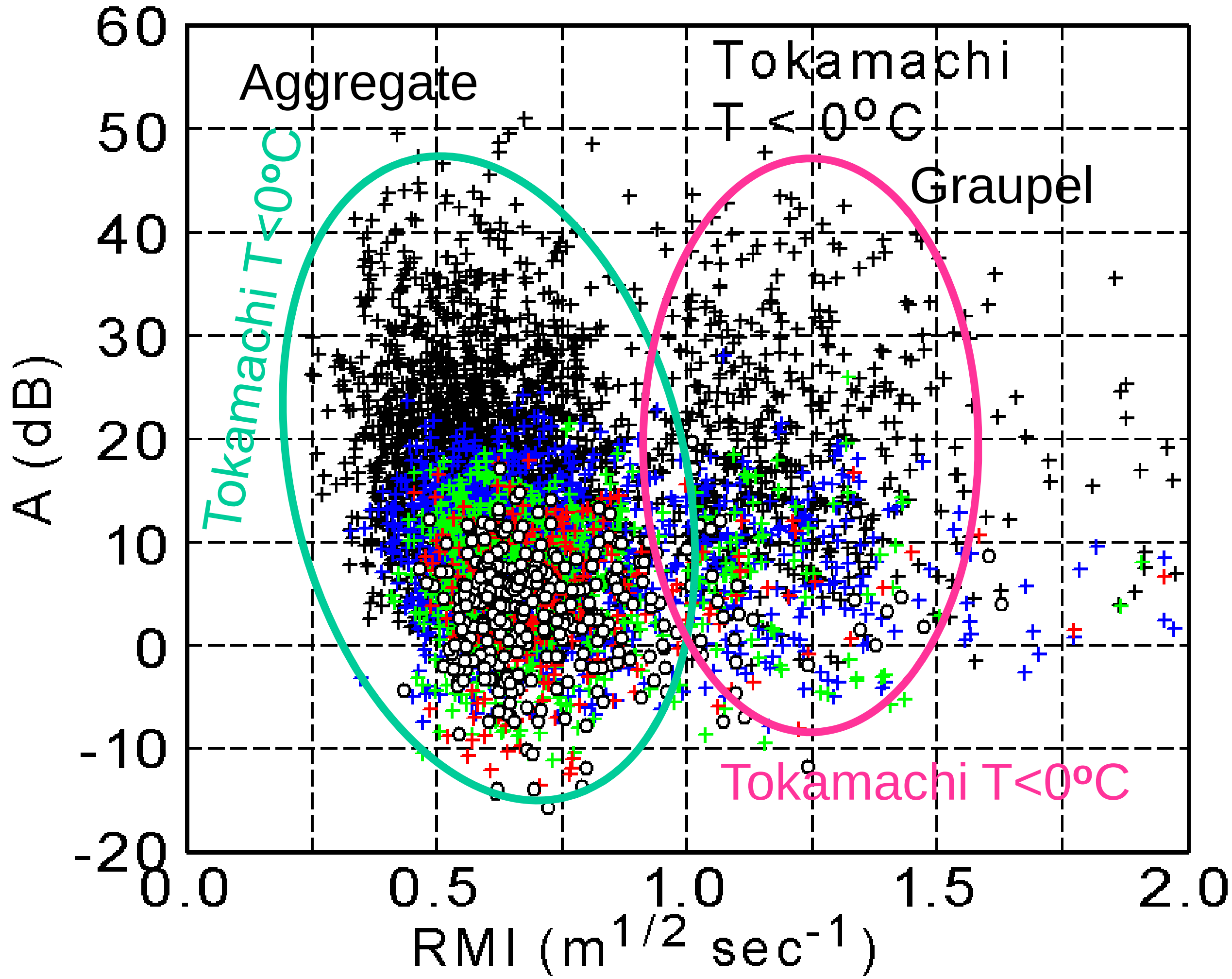


Colors : SR-2A precipitation intensity
0-1 mm hour^{-1} (gray)
1-2 mm hour^{-1} (blue)
2-3 mm hour^{-1} (green)
3-4 mm hour^{-1} (red)
>4 mm hour^{-1} (open)

- *The result is consistent with the existing studies.*
- *Highly scattered .*

Result

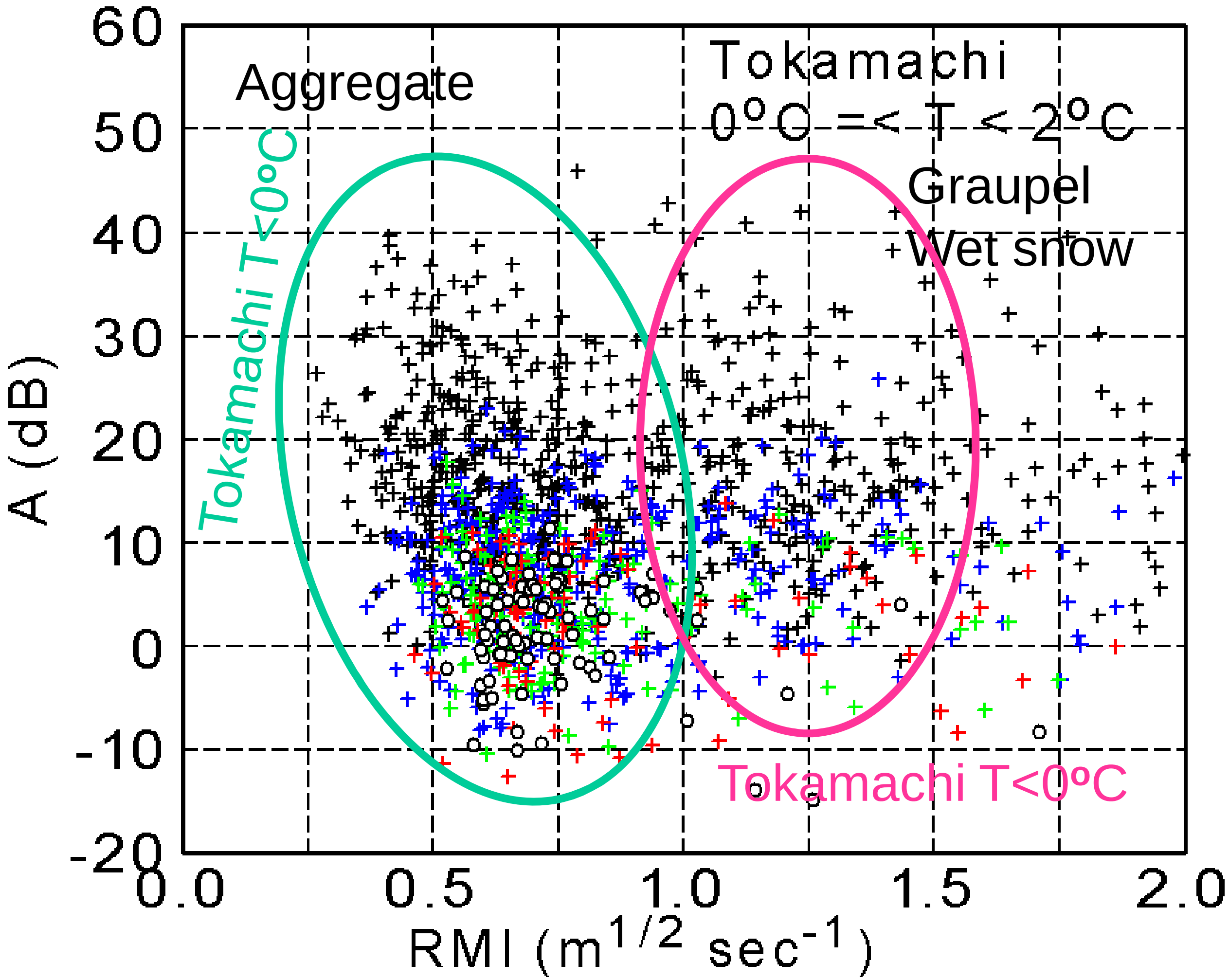
- As for graupel, it is difficult to find a correlation between *A* and RMI, however, *A* was smaller when the precipitation intensity was larger.



Colors : SR-2A precipitation intensity
0-1 mm hour^{-1} (gray)
1-2 mm hour^{-1} (blue)
2-3 mm hour^{-1} (green)
3-4 mm hour^{-1} (red)
>4 mm hour^{-1} (open)

Result

- As for wet snow, *A* was a little smaller than dry snow. *A* was smaller when the precipitation intensity was larger.



Colors : SR-2A precipitation intensity

0-1 mm hour^{-1} (gray)

1-2 mm hour^{-1} (blue)

2-3 mm hour^{-1} (green)

3-4 mm hour^{-1} (red)

>4 mm hour^{-1} (open)

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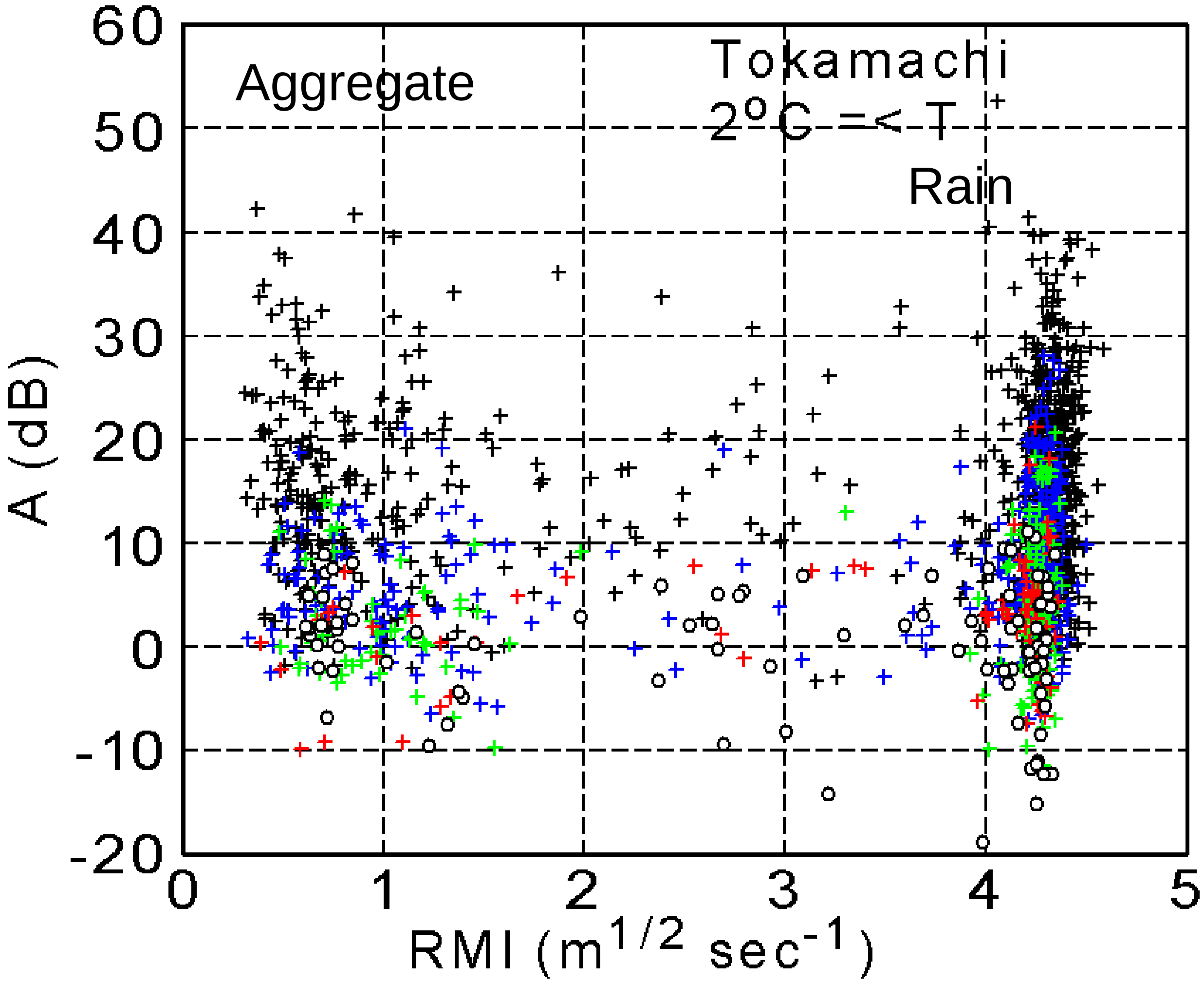
Result

- As for rain, the dependency on the precipitation intensity was seen.

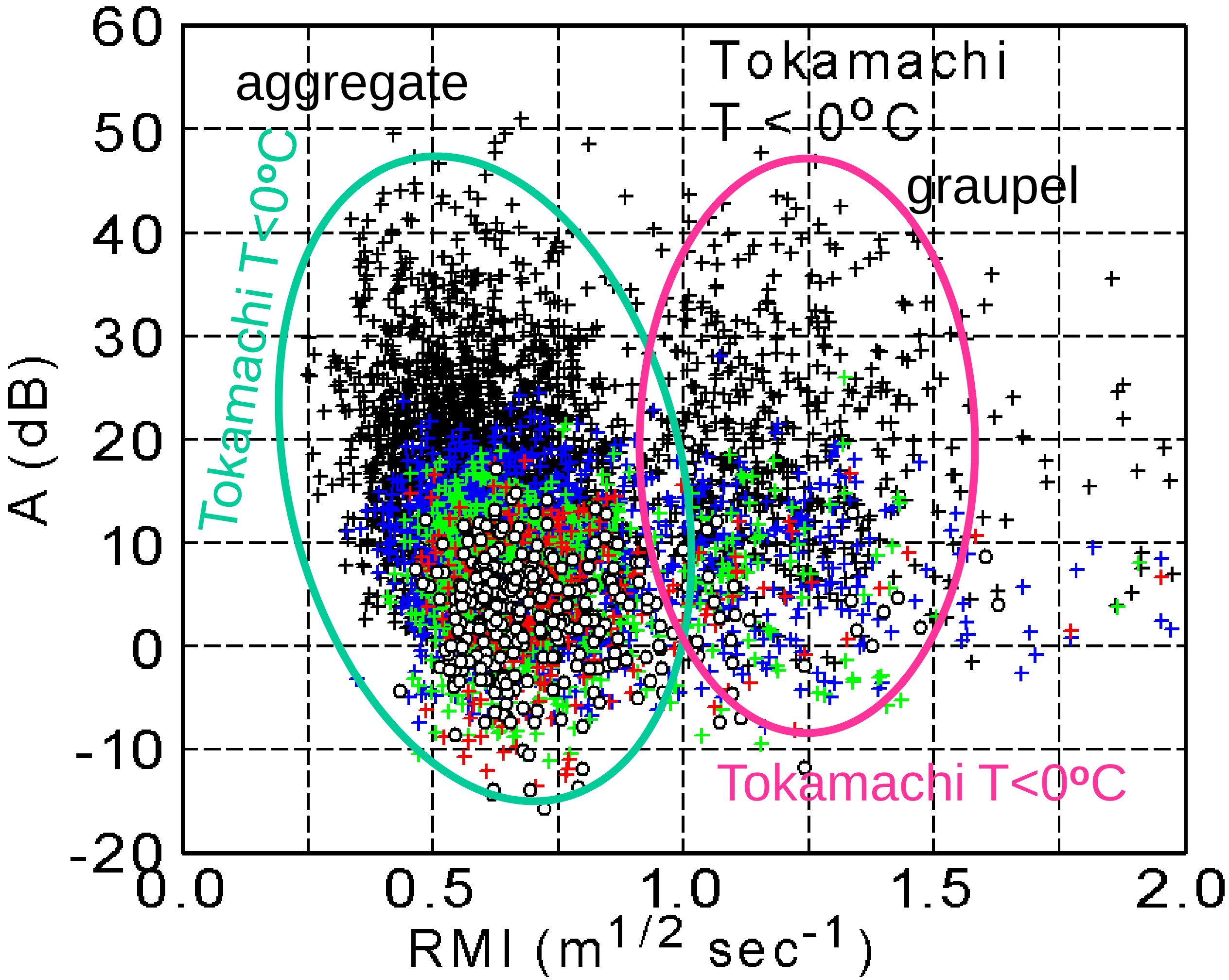


Colors : SR-2A precipitation intensity

0-1 mm hour^{-1} (gray)
1-2 mm hour^{-1} (blue)
2-3 mm hour^{-1} (green)
3-4 mm hour^{-1} (red)
>4 mm hour^{-1} (open)

Result

- At Tokamachi site, Many of *A* for snow aggregate seems to be smaller than *A* for graupel.

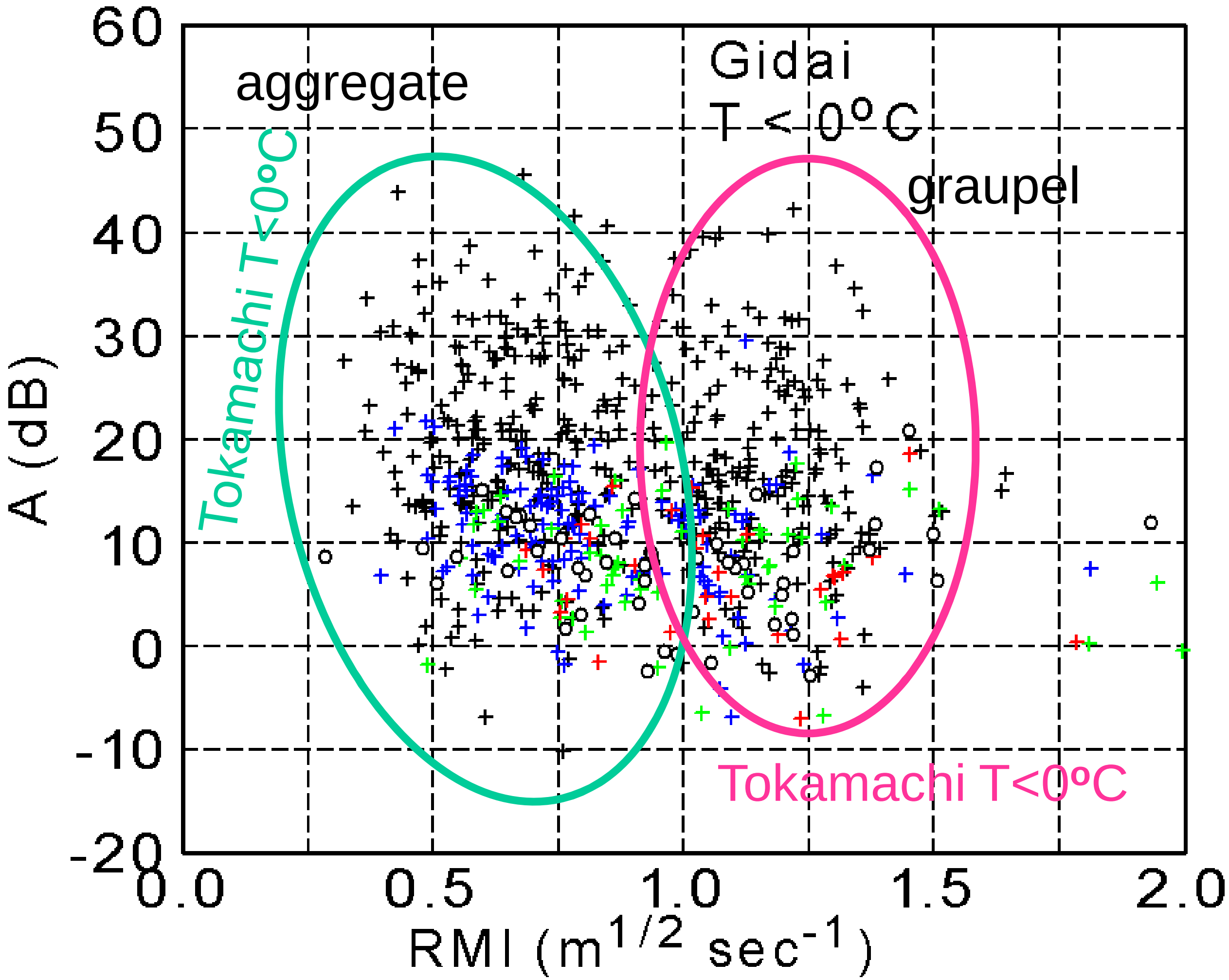


Colors : SR-2A precipitation intensity

- **0-1 mm hour^{-1} (gray)**
- **1-2 mm hour^{-1} (blue)**
- **2-3 mm hour^{-1} (green)**
- **3-4 mm hour^{-1} (red)**
- **>4 mm hour^{-1} (open)**

Result

- At Gidai site, *A* for snow aggregate seems to be larger than *A* for graupel.



Colors : SR-2A precipitation intensity
0-1 mm hour^{-1} (gray)
1-2 mm hour^{-1} (blue)
2-3 mm hour^{-1} (green)
3-4 mm hour^{-1} (red)
>4 mm hour^{-1} (open)

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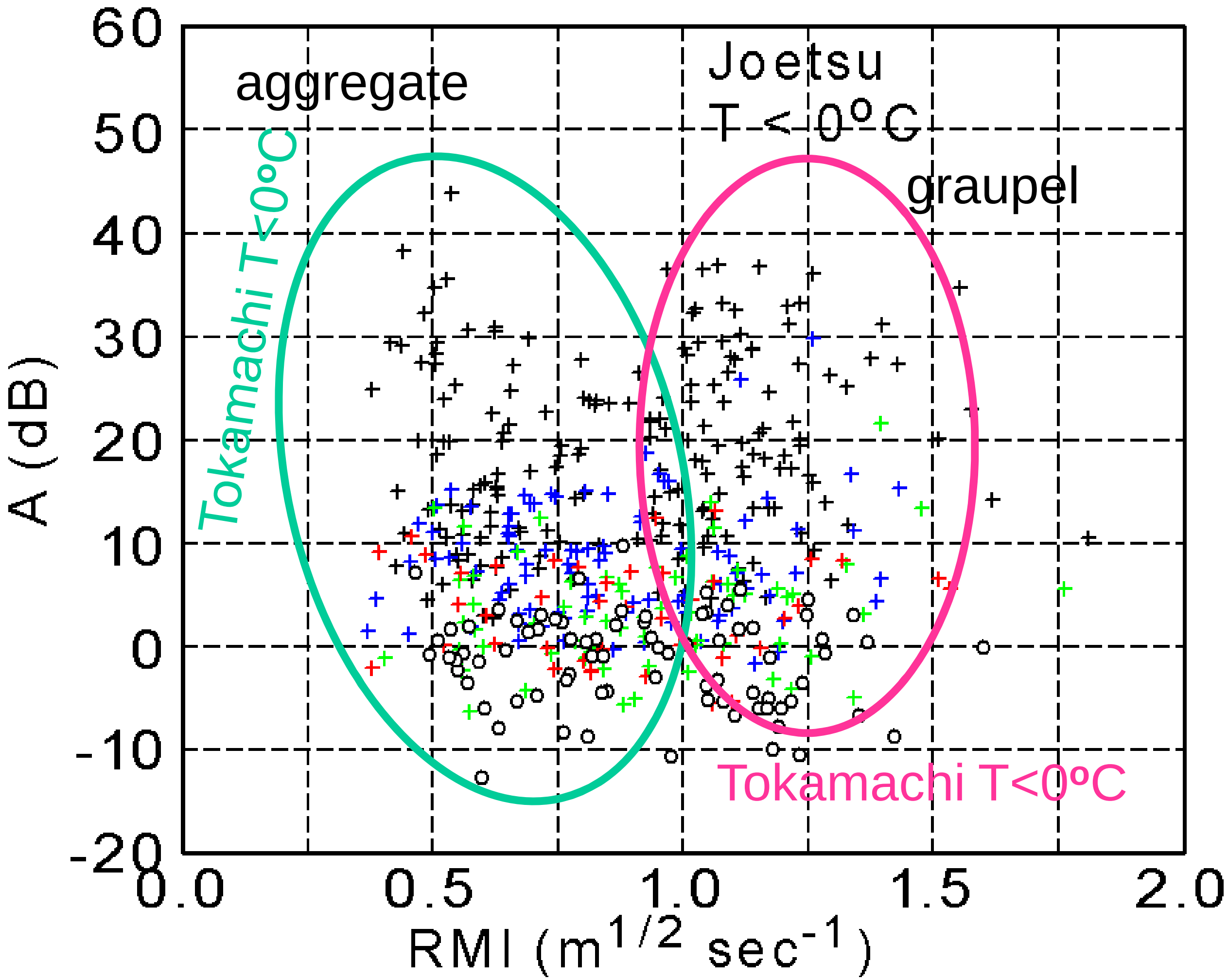
Result

- At Joetsu site. *A* is smaller. Clearly, it is because of the high radar beam (~2200m). Vertical change of snow particles will be observed next winter.



Colors : SR-2A precipitation intensity

0-1 mm hour^{-1} (gray)

1-2 mm hour^{-1} (blue)

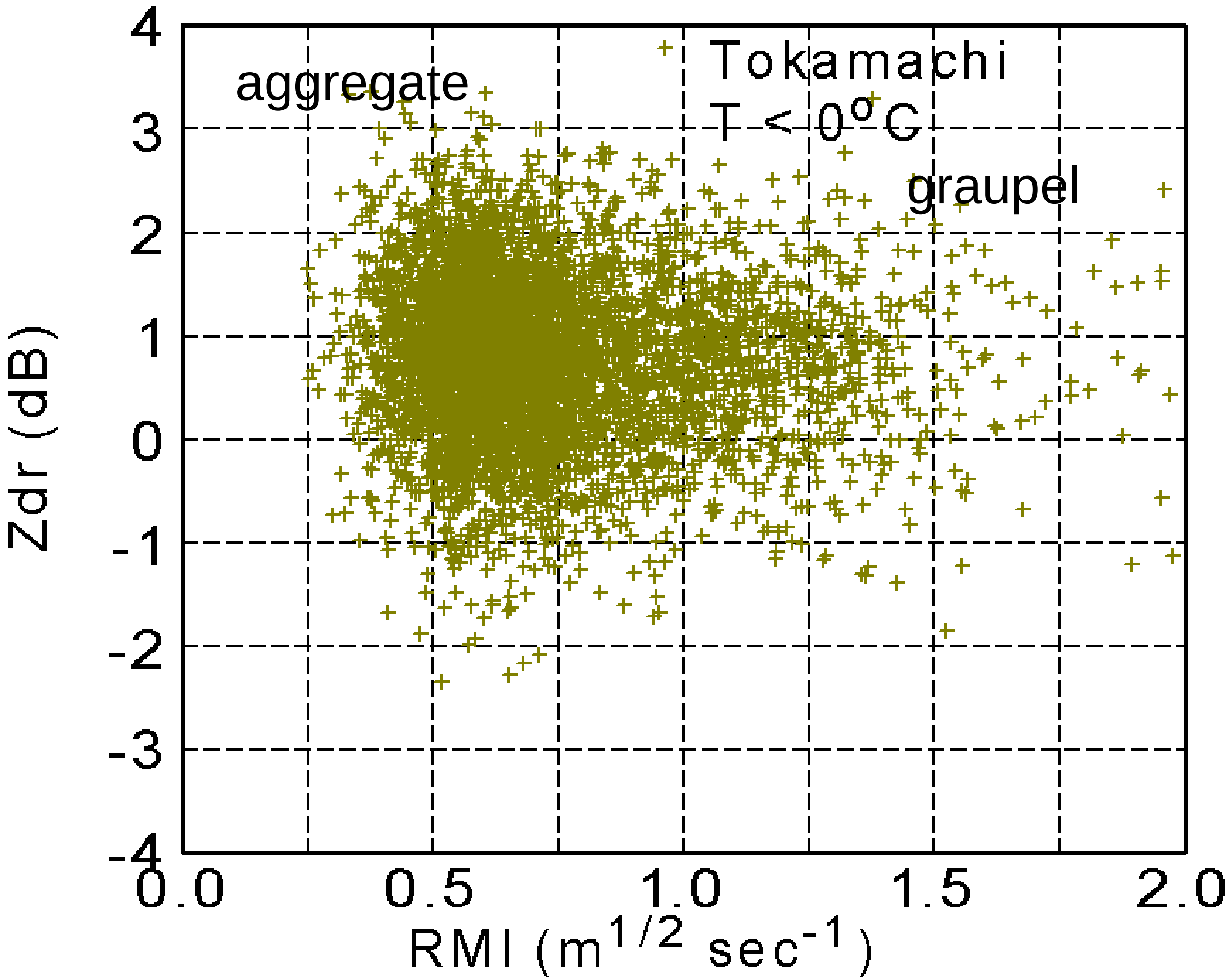
2-3 mm hour^{-1} (green)

3-4 mm hour^{-1} (red)

>4 mm hour^{-1} (open)

Result

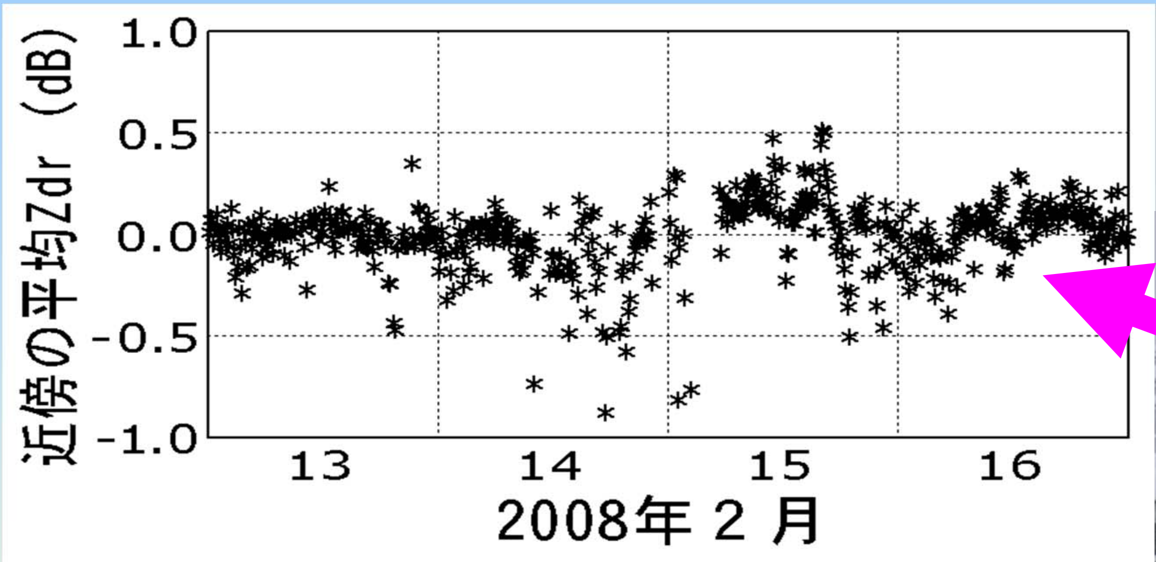
- Simple scattergram between RMI and Zdr did not yield good results.

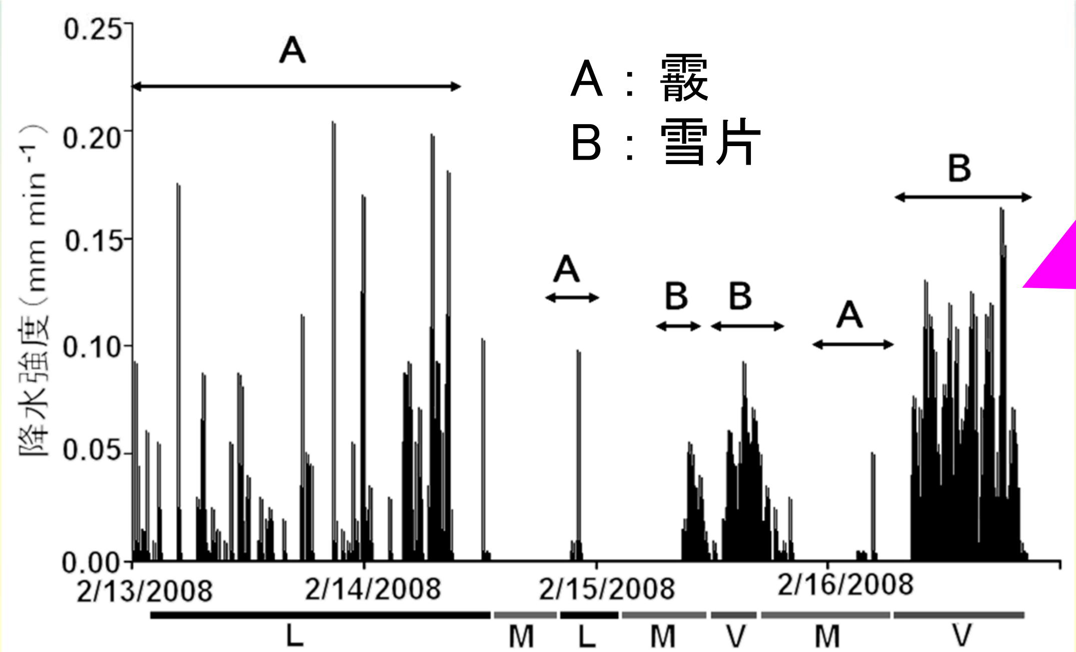


- Zdr Offset is not corrected.

- Appropriate averaging will enable to detect the kind of prevailing precipitation particle using Zdr.

中井専人・石坂雅昭・山口悟・本吉弘岐(2010, 春の気象学会, 雪氷北信越)





Contents

Summary

- *We conducted observations of precipitation particles, high-resolution precipitation intensity in the X-POL radar coverage area.*
- *Precipitation particle analysis method using Dc, Vc, and RMI was applied to the observed data.*
- *The coefficient of Ze-R relation (A) and RMI showed negatively correlated tendency in case of dry aggregates.*
- *Vertical profile of precipitation particles should be considered.*
- *Appropriate preprocessing, horizontal averaging or statistics is necessary for comparison.*

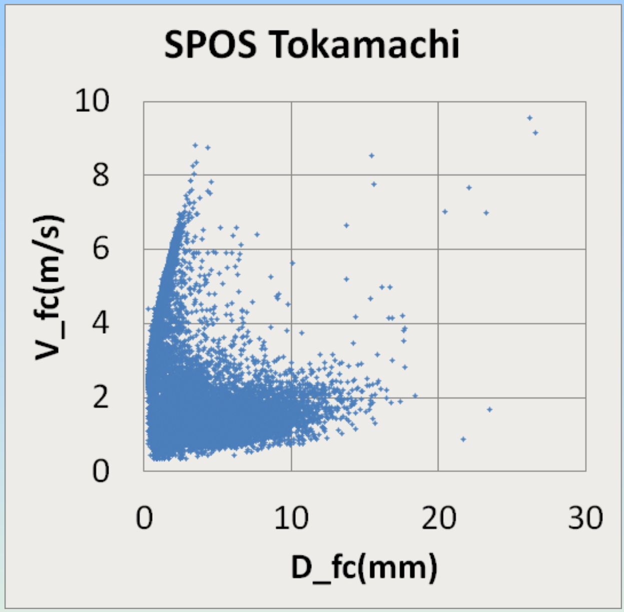
Ongoing and future works

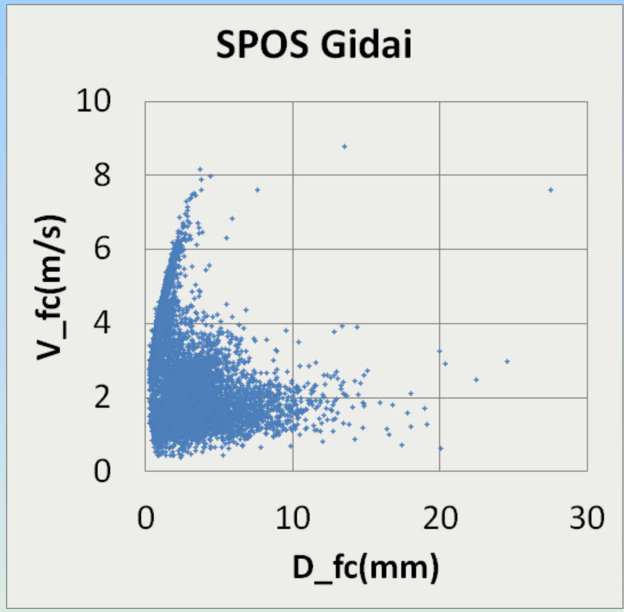
- *Observations will be made in the following three winters. We are expecting to derive some relationship among Dc, RMI, coefficient of Ze-R relation, and polarimetric parameters by conducting analyses using these data.*

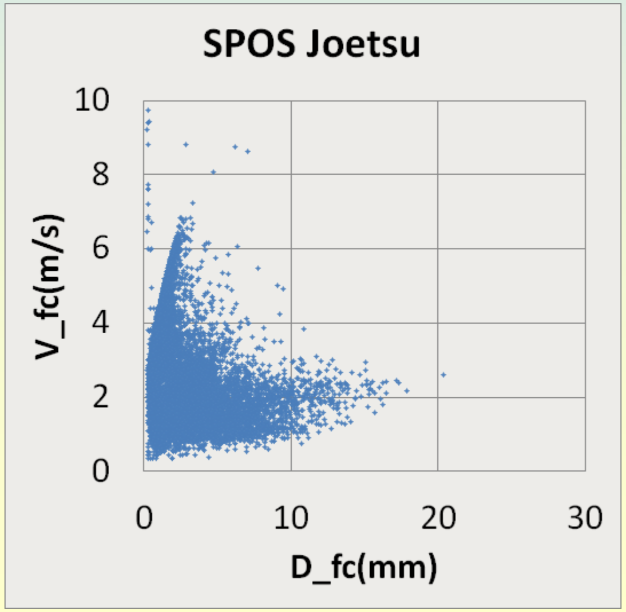
- *This research will contribute to*
  - *supply the fundamental data on parameter setup in the development of the GPM standard algorithms,*
  - *provide correct snowfall data with respects to quality and to quantity to the snow and ice disaster prediction, and*
  - *the establishment of the ground-based quantitative precipitation estimation in the winter seasons.*


Thank you !!!
Acknowledgments. The speaker express hearty thanks to all the members of this observational research. Observations were conducted with great assistance of research organizations and universities who gave us the location, power supply and so on.
Snow and Ice Research Center at 1447JST on January 31, 2011
(Photo by Nakai, S.)

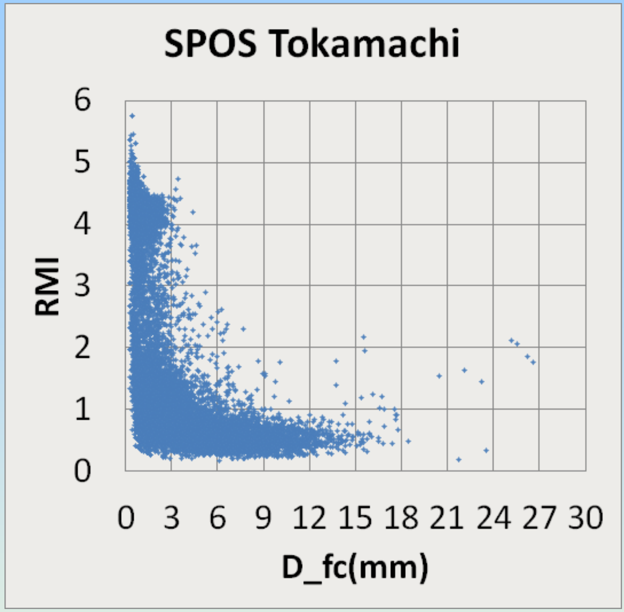
Result : V-D distribution

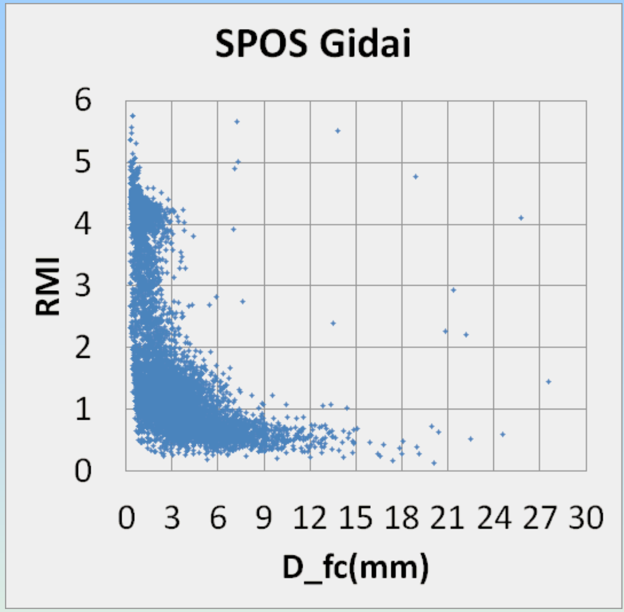


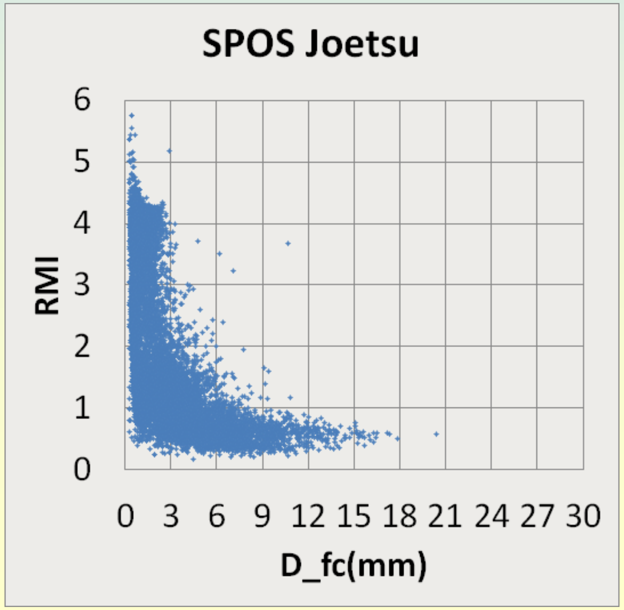




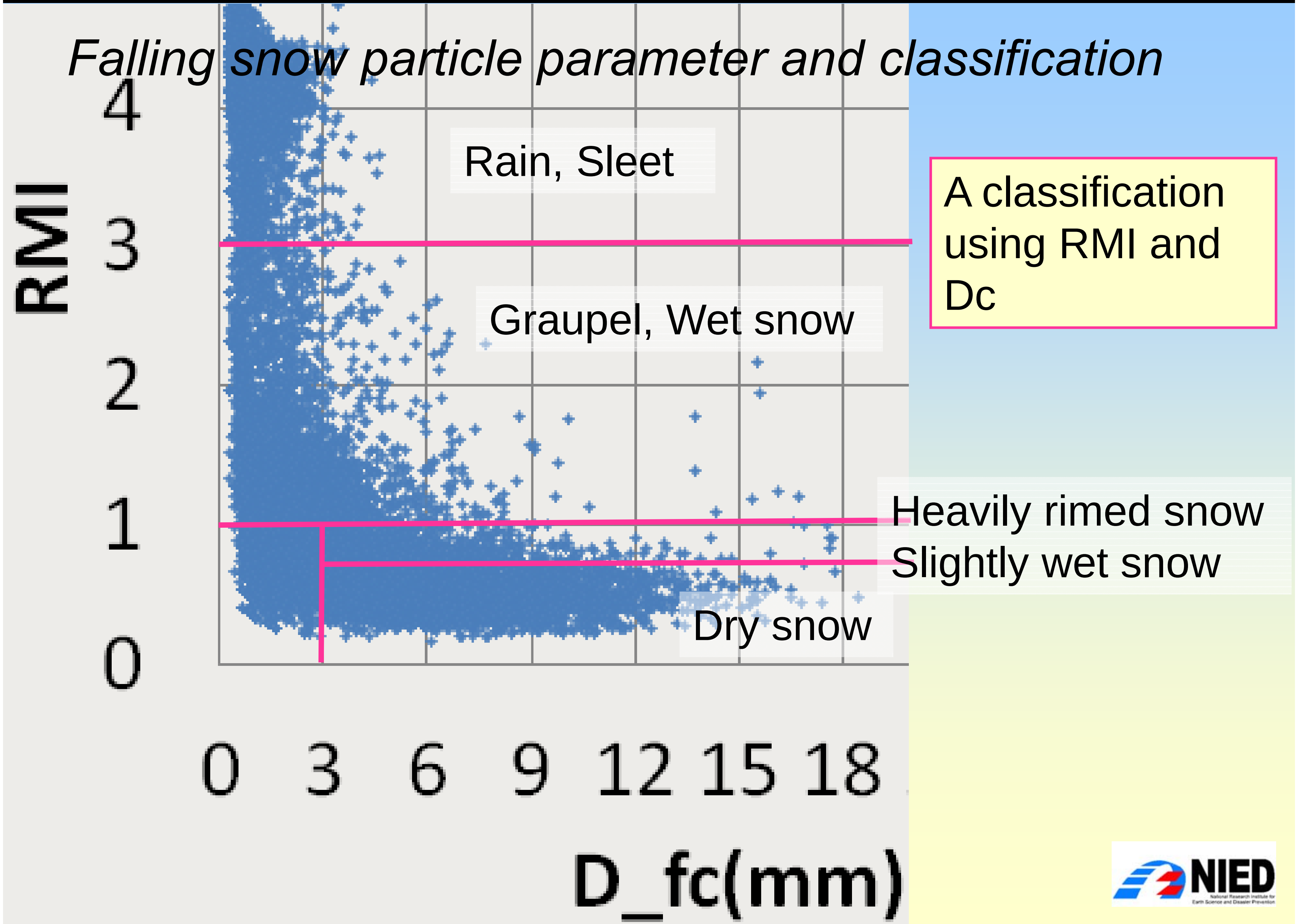
Snow particle observations : PARSIVEL







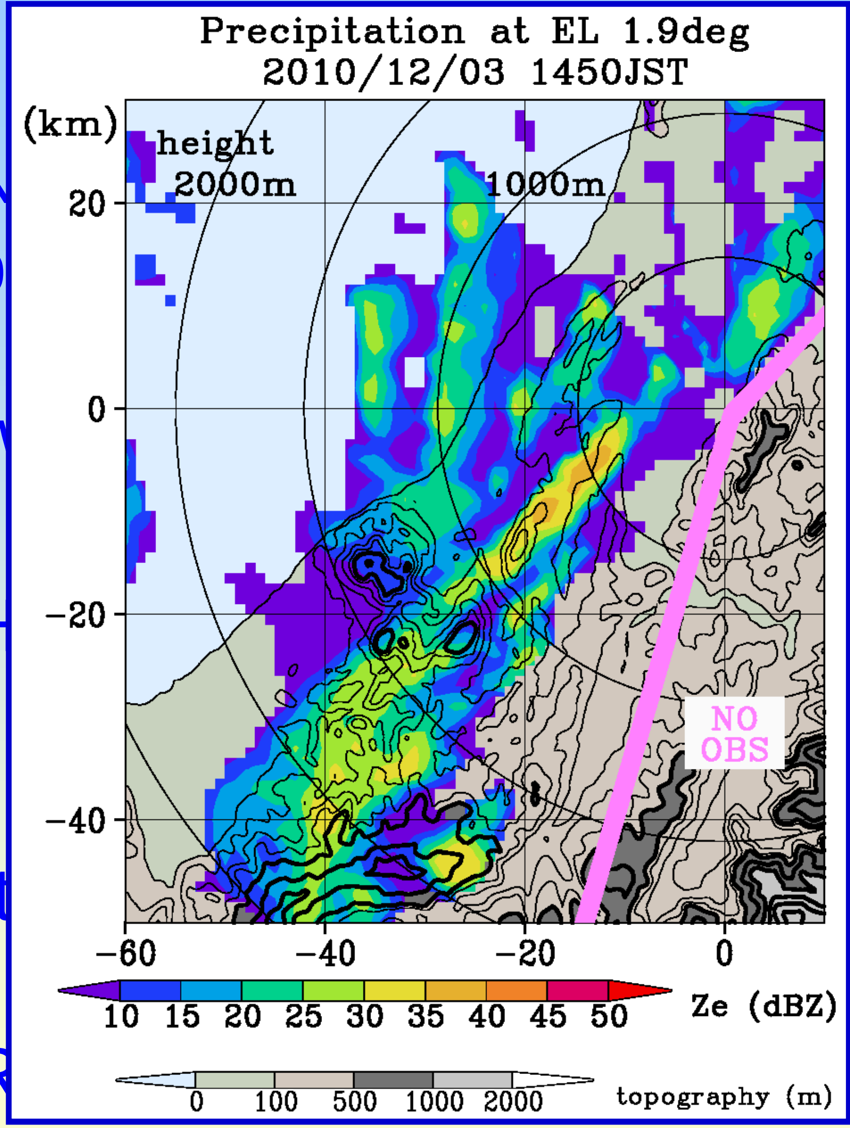
Falling snow particle parameter and classification



A classification using RMI and Dc

3. Observations : X-POL Radar

N
p
W
H



a quick-look image

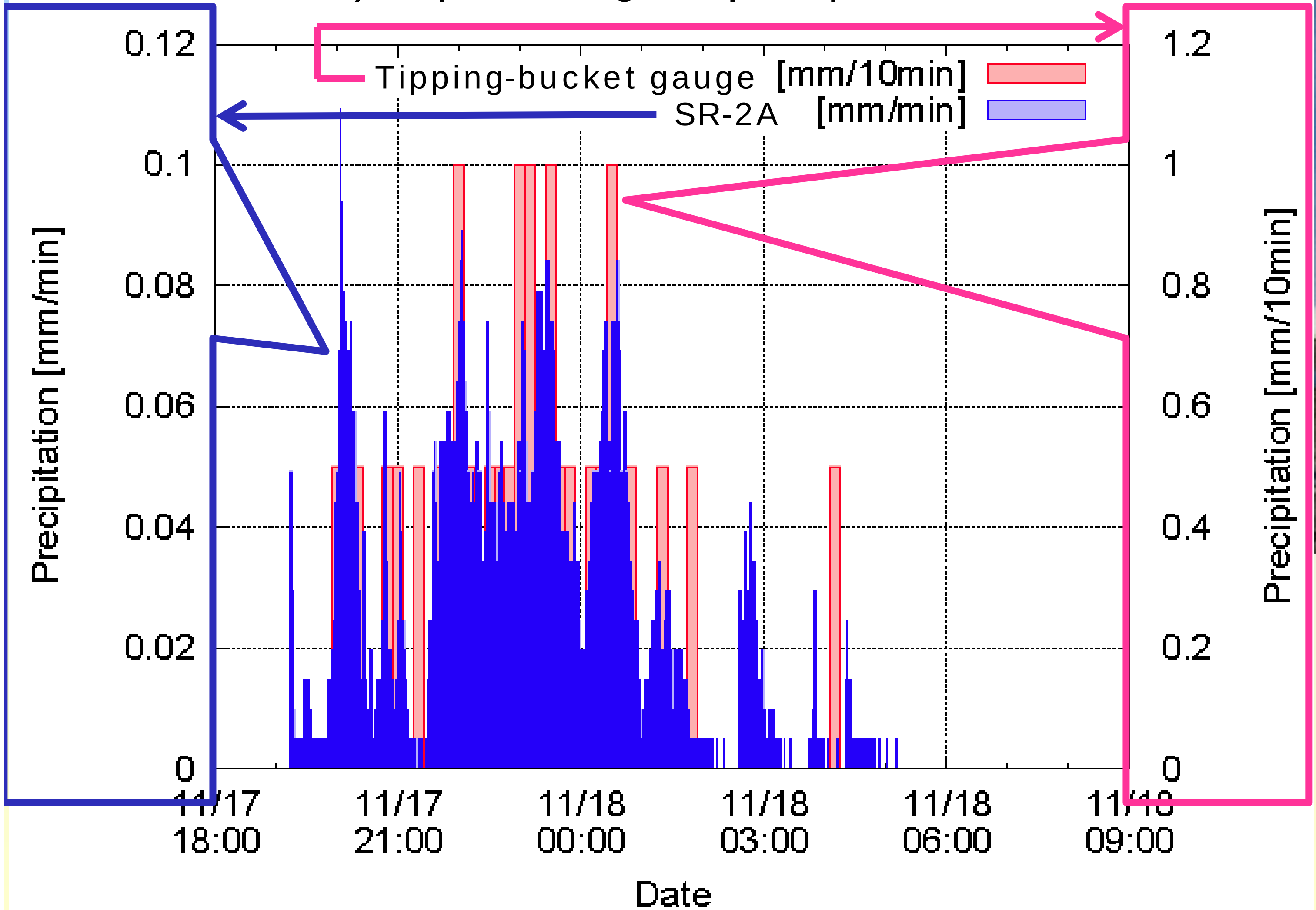
Task schedule 10-minute int

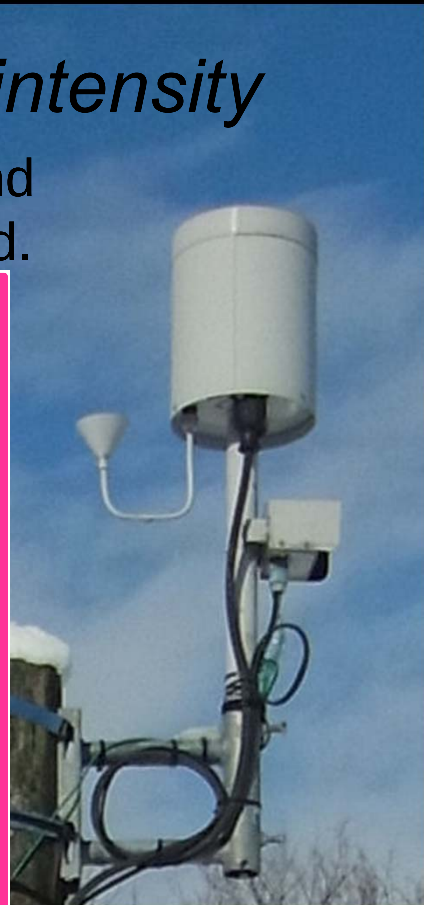
Tasks 12-elevation

sector PPI, R

Snow particle observations : Precipitation intensity

- For both time and sampling resolution are high (1 min. and 0.0052 mm), rapid change of precipitation can be detected.





an example data at Joetsu (HRC) site