Ground Validation of Physical Parameters of Dry/Wet Snow Particles Based on Sophisticated Measuring System & Data Analysis Techniques

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Contents

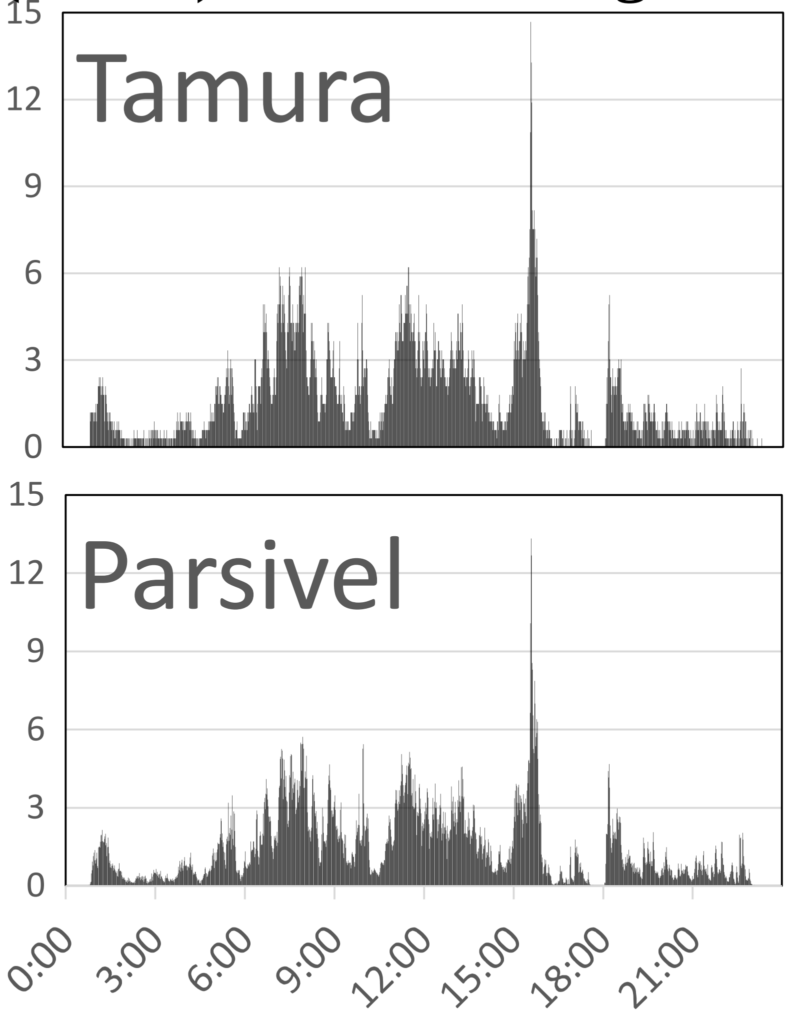
- Calibration of instruments
- Conventional radar for GPM/GV
- Detection of Darkband
- Classification & Density of snow particles
- Ongoing study

High temporal & continuous measurement of Rainfall/Snowfall Intensity

Electro-balance

Drop count-method
Tamura-method

R(mm/h);1 min. average



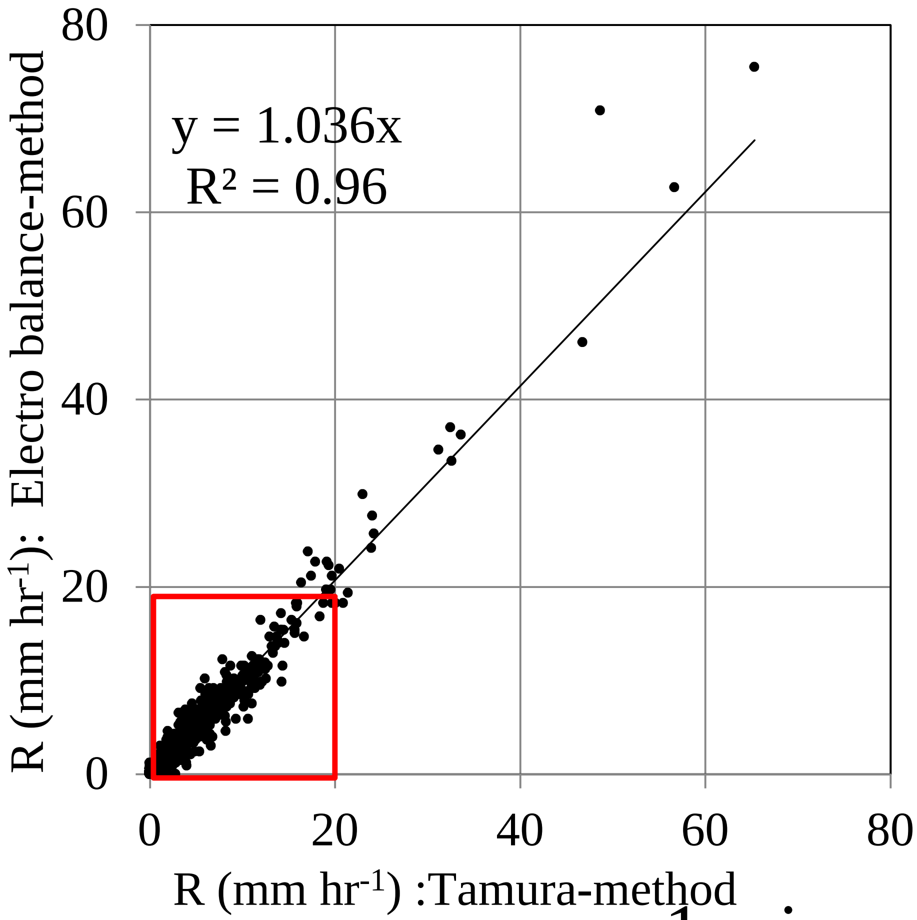
07 Nov., 2012

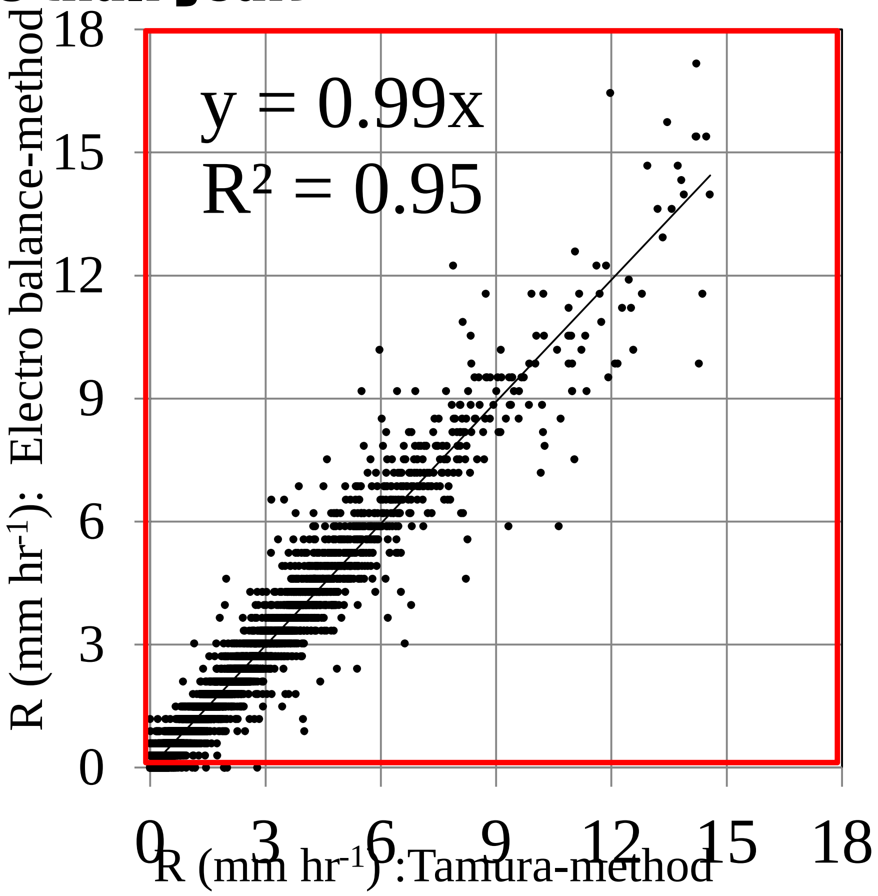
Rainfall Intensity

Eletro-balance & Tamura method

Resolution 0.003mm/hr 0.3mm/hr per 1-minute

April-Oct. 2013 (half year)



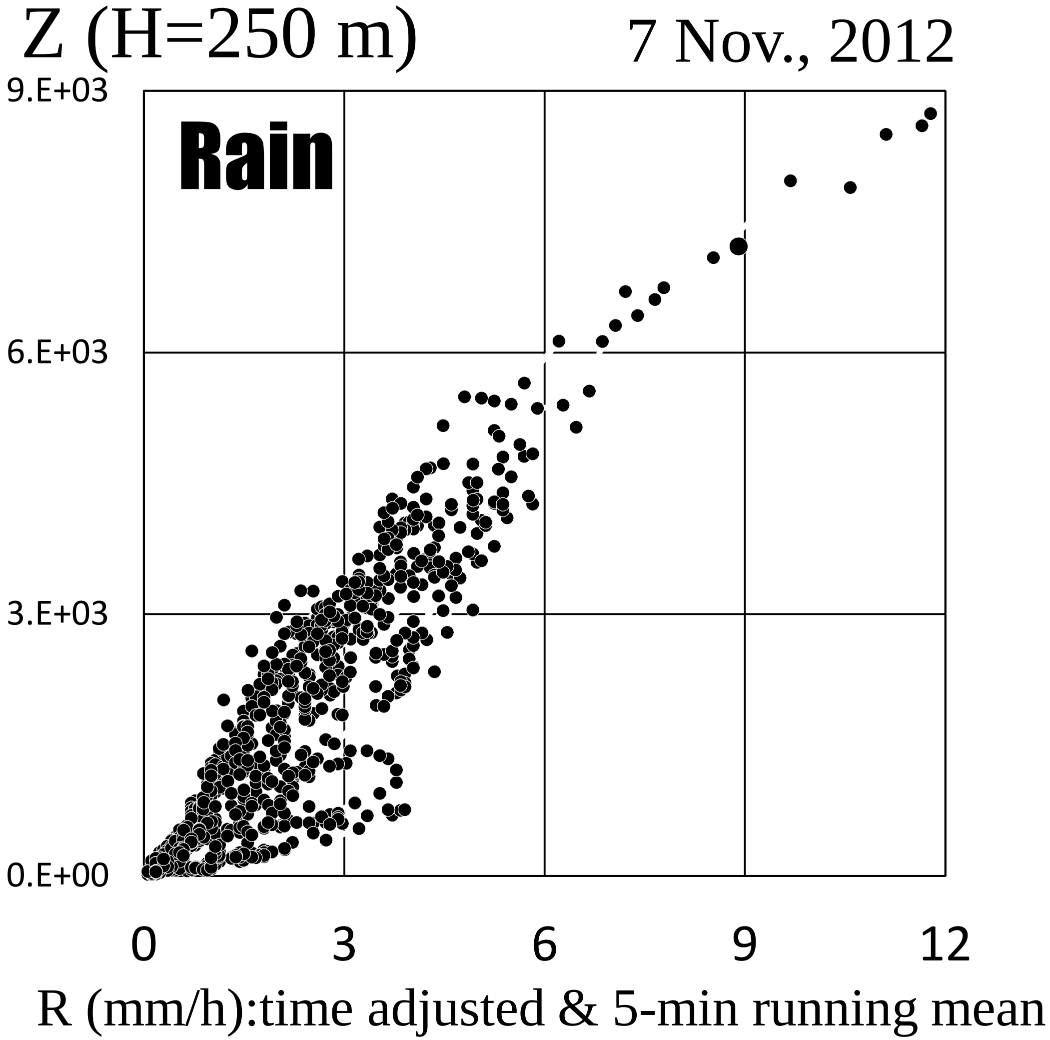


1 min. average

Z(K_a-radar) –Rainfall Intensity Oct. 2012 – May 2013

K_a-band radar

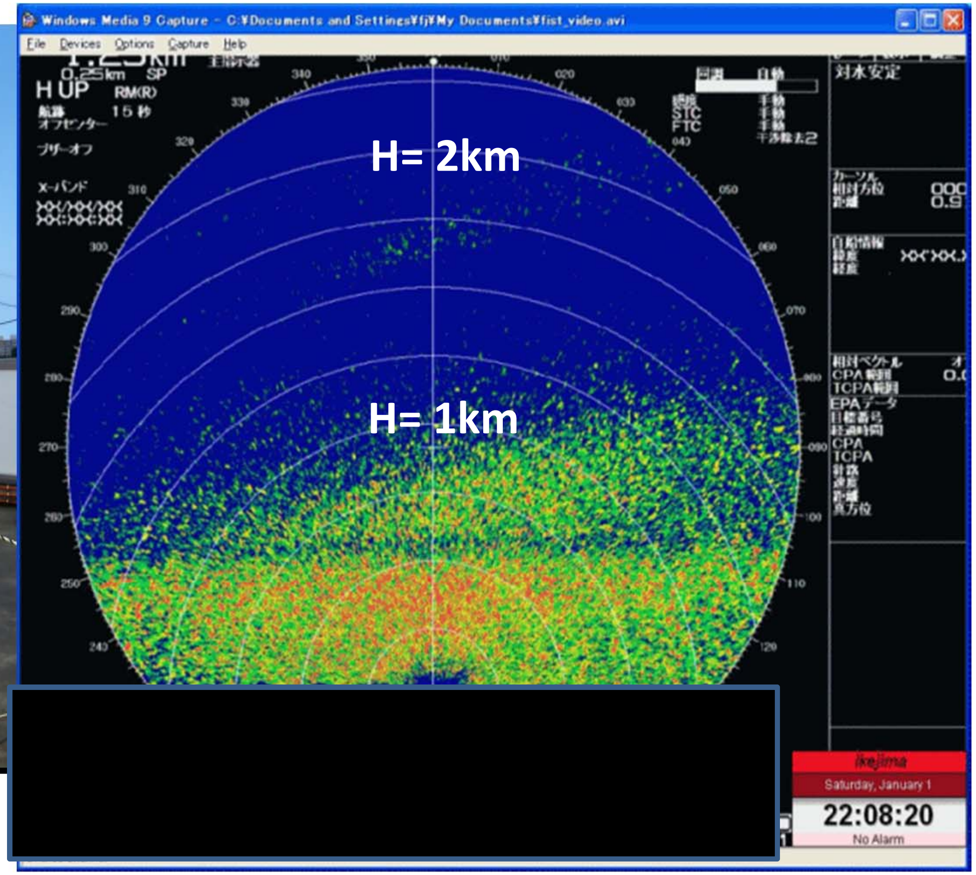
Vertically pointing



Conventional X-band radar to monitor High Spatial & Temporal Change of Various types of Precipitating Clouds

Marine X-band radar

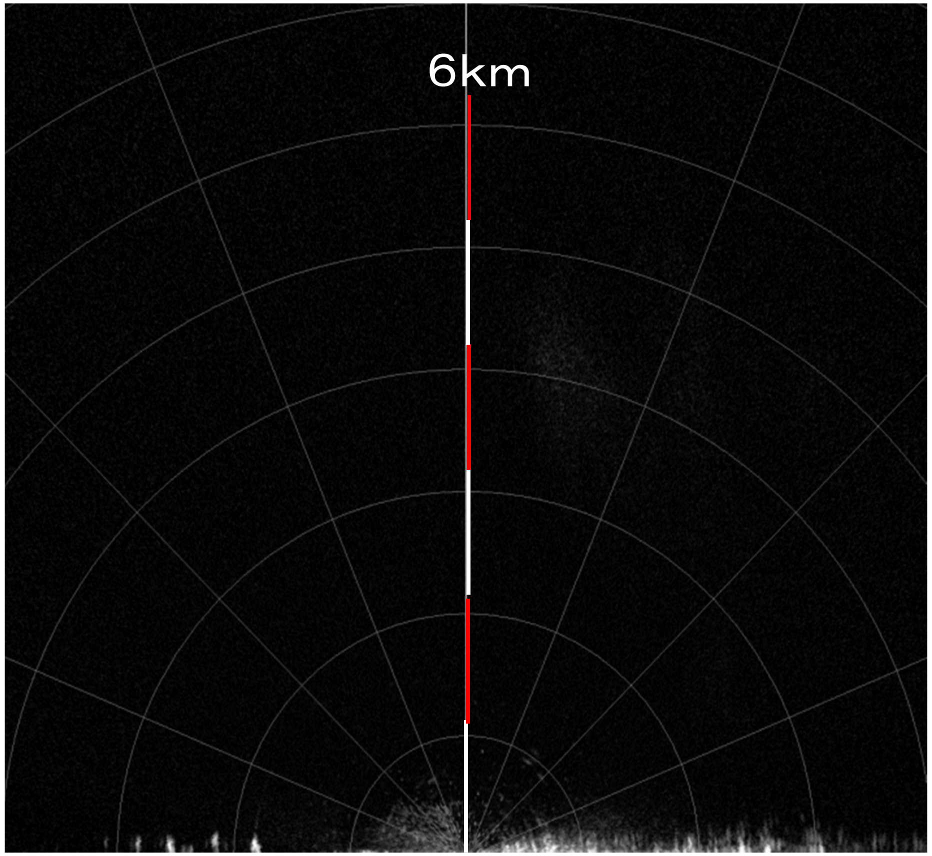
High Spatial (15 m)& Temporal (2 sec/scan) resolution



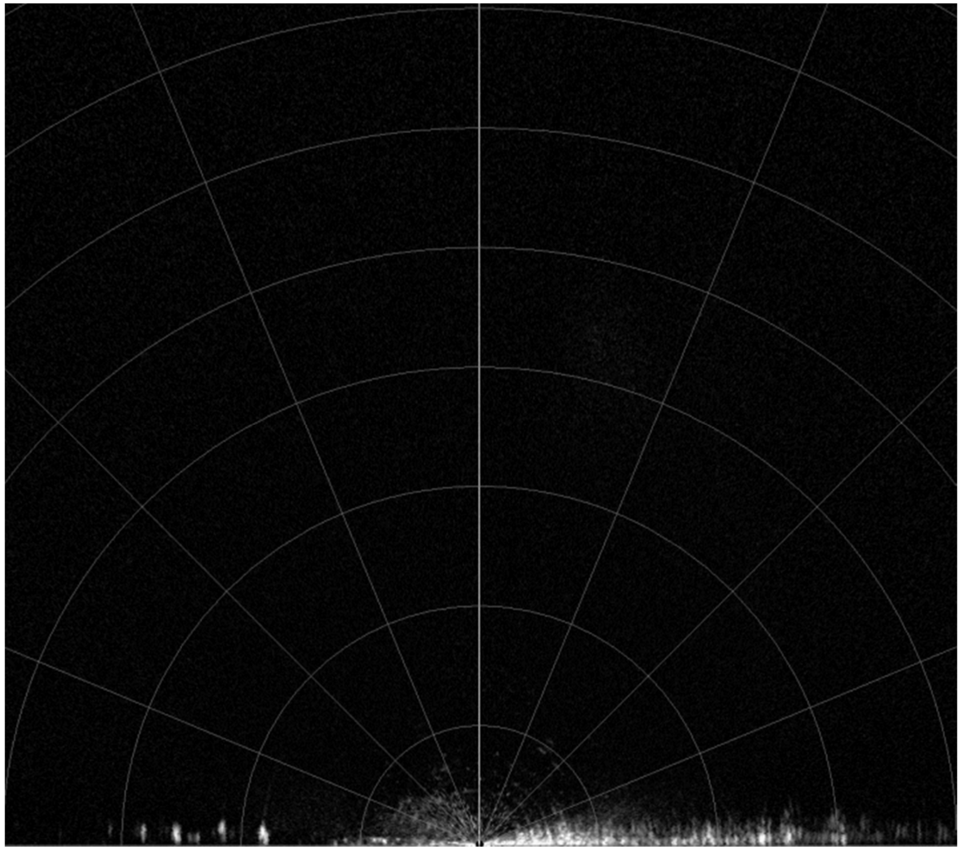
Short Range (Range = 6 km) & Low sensitivity (-90 dBm)

Strong convective echo

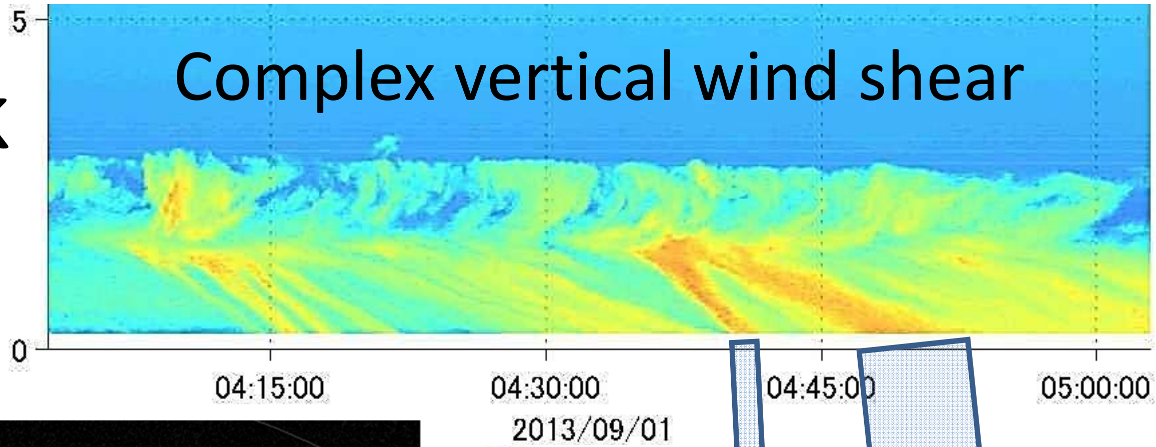
2sec interval



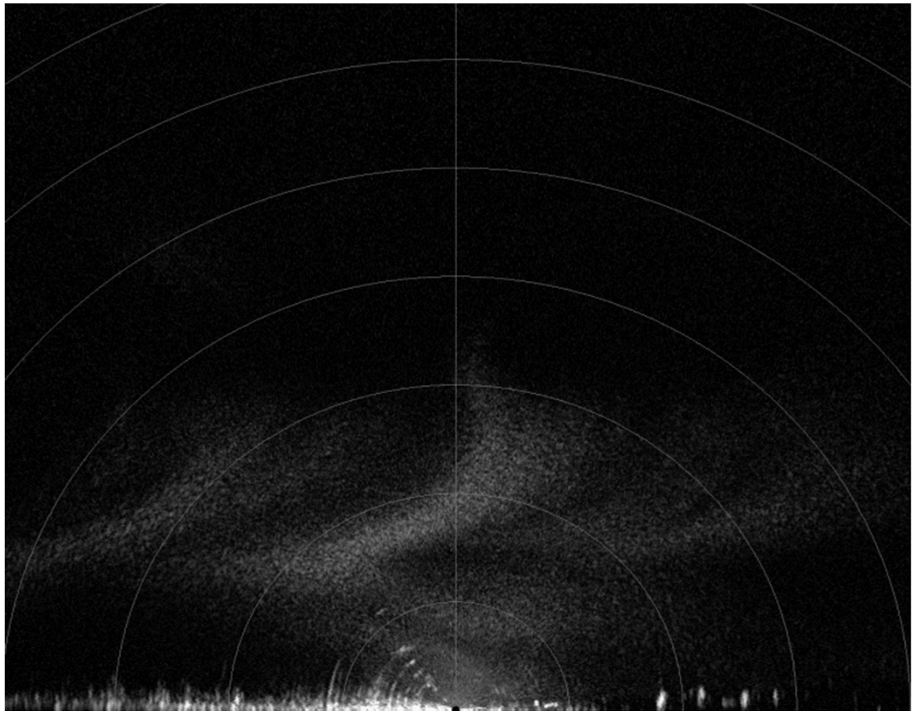
1 minute interval

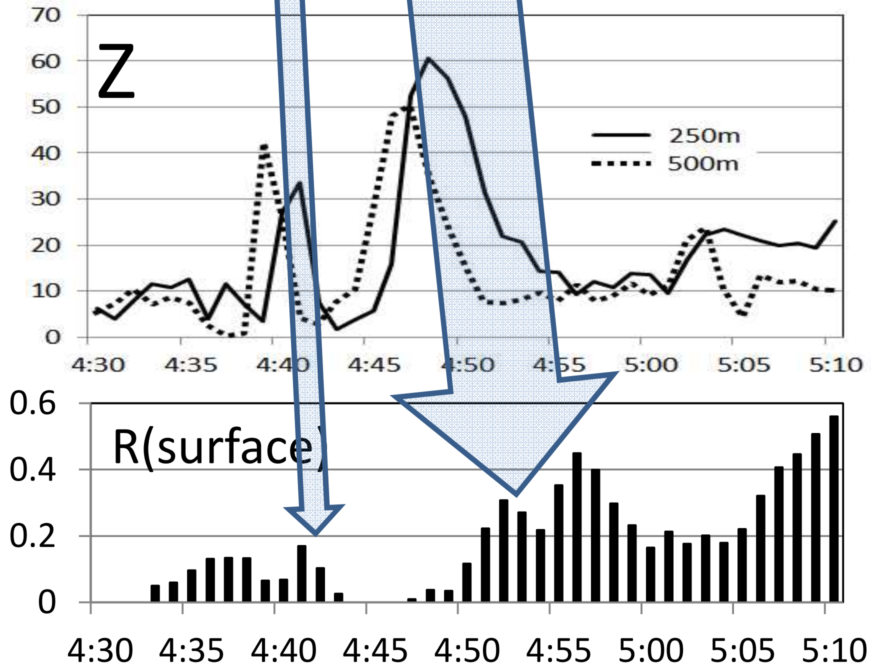


Rain Streak



Size Sorting

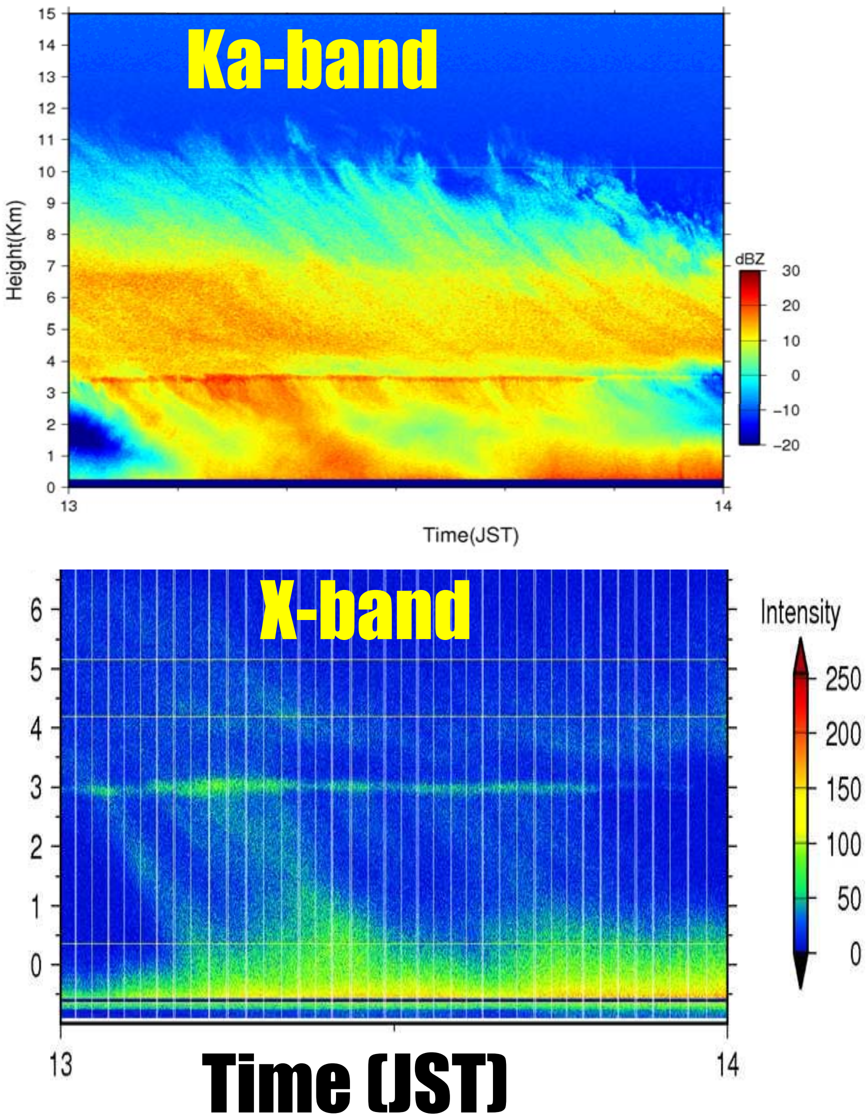


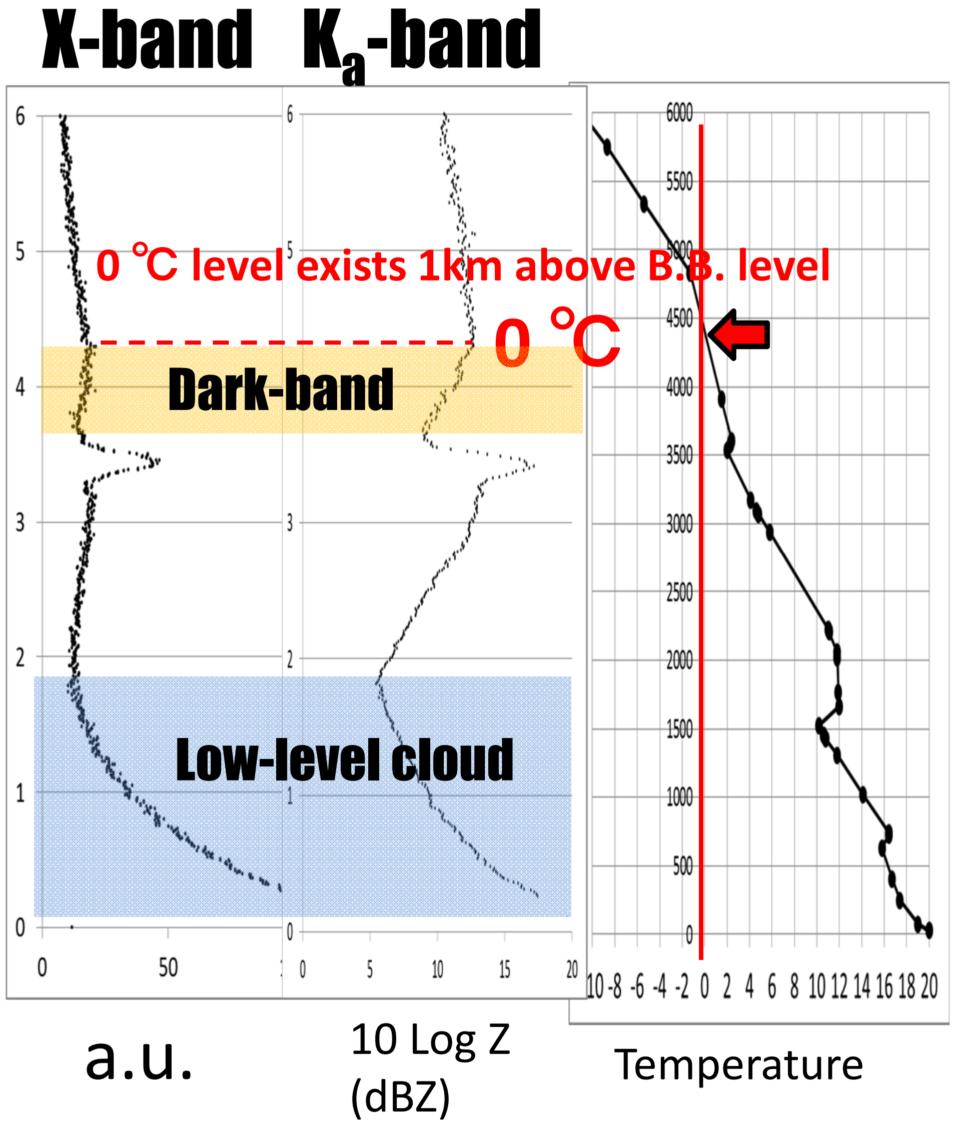


Useful to explain variability in Z-R relationships & Cloud type
⇒Should deploy globally this cheap and conventional radar

Detection of Darkband by K_a & X band radars

31 August 2013

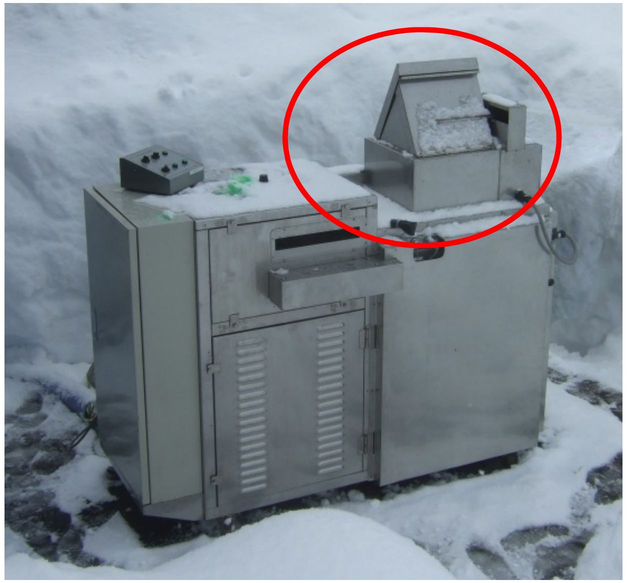




Fujiyoshi (2014) (under revision)

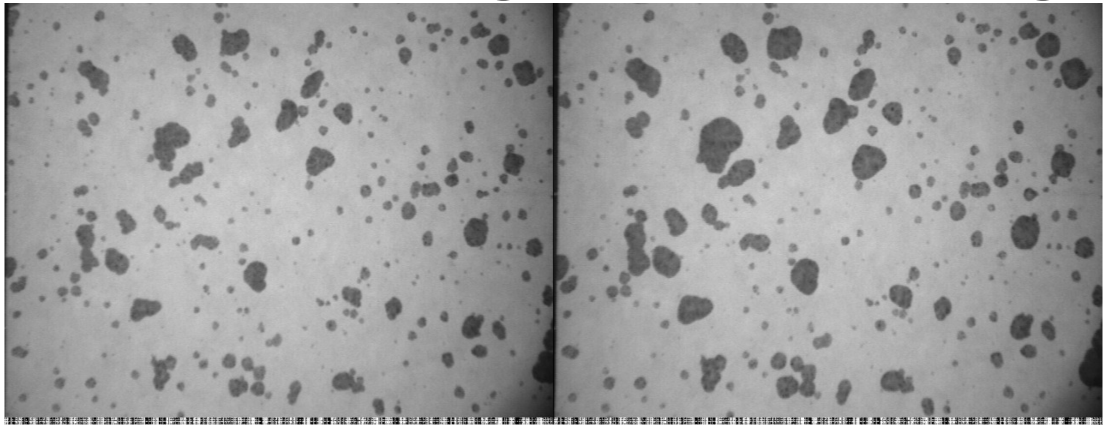
Depth of darkband decreases with increasing precipitation intensity

Measurement of Melted Fraction



Sasyo et al. J. Met. Soc. Japan (1991)

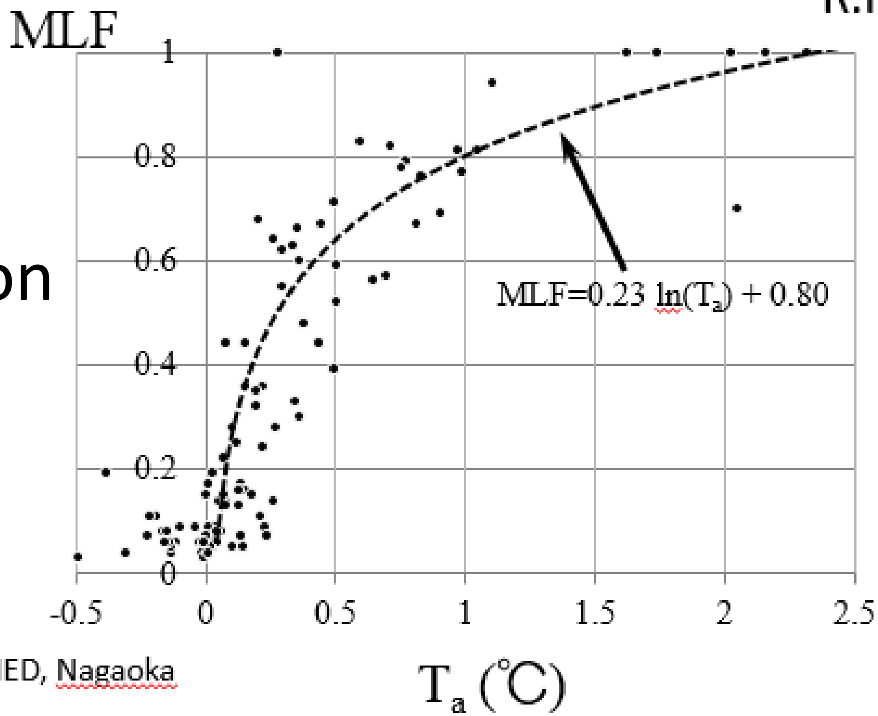
Before Heating After Heating



Mean Melted Fraction

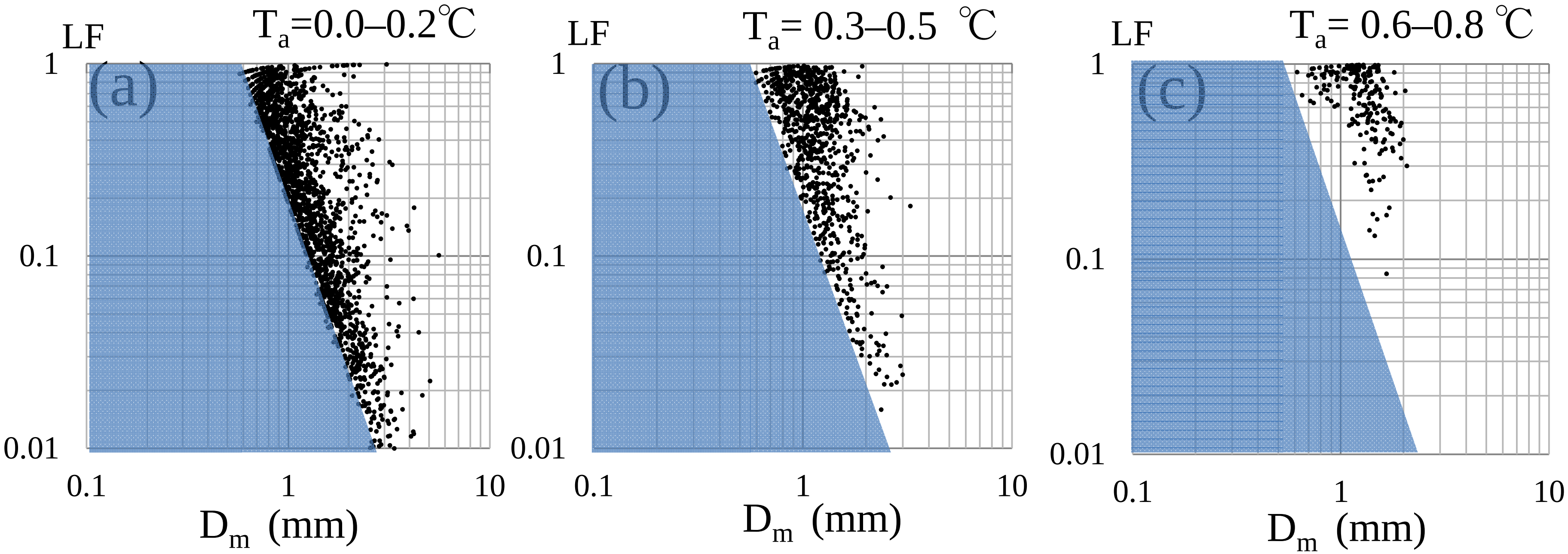
$(\Sigma S_{before}/\Sigma S_{after})$

R.H.>90%



NIED, Nagaoka

Temperature & Size dependency of Liquid Fraction



Melted Diameter (mm) R.H.>90%

Fujiyoshi (2014) (under revision)
Misumi et al. (2014) (under revision)

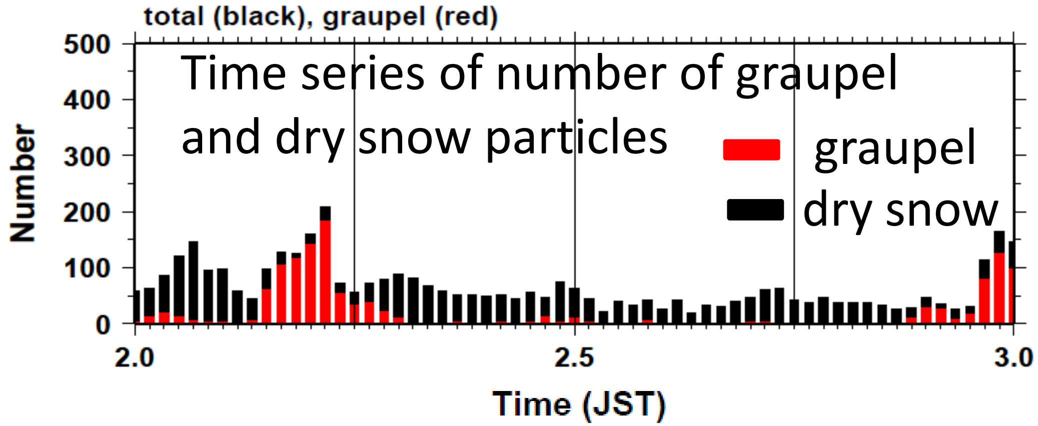
Classification & Density of snow particles

Classification of Graupel

diameter (D_{eq}) ≥ 2 mm

oblateness: 0.9 ~ 1.1

V(m/s)> 0.6 D_{eq}(mm)



Size Distribution of Graupel

$$N(D)=N_0\exp(-\lambda D)$$

$$N_0=200 \times R^{0.72} ; \Lambda = R^{0.16}$$

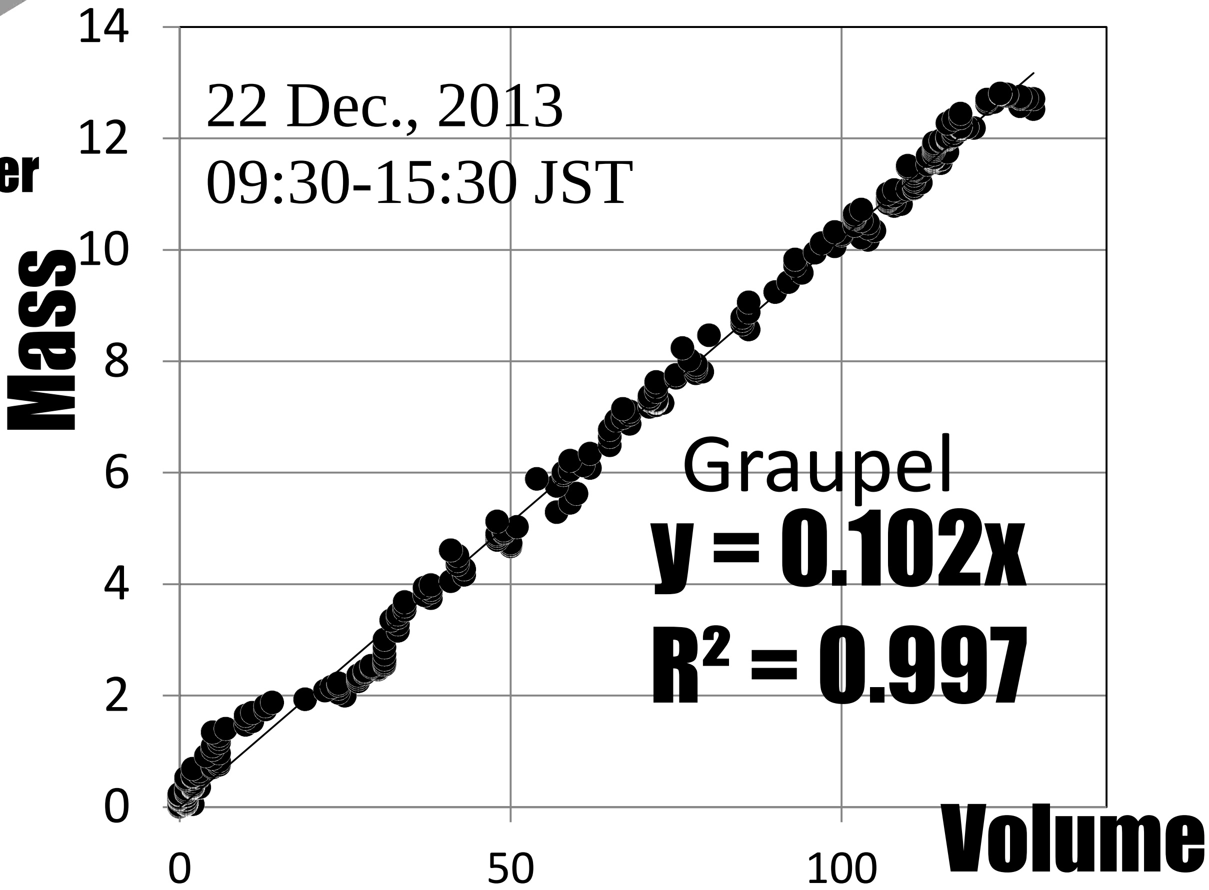
D(Max. size)-V relationship

$$V(m/s)=0.745 \times D(mm)$$

D: 2-10mm

Bulk density of new fallen snow
Bulk density = Mass/Volume

Mass=Electro-balance
Volume=Snow depth×S

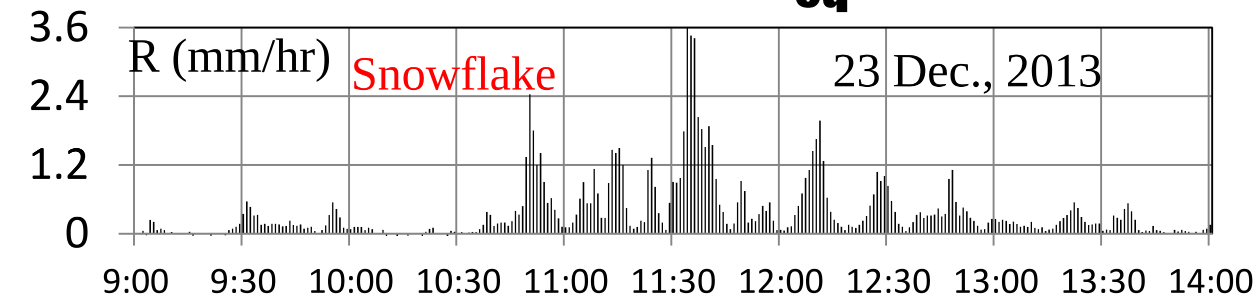


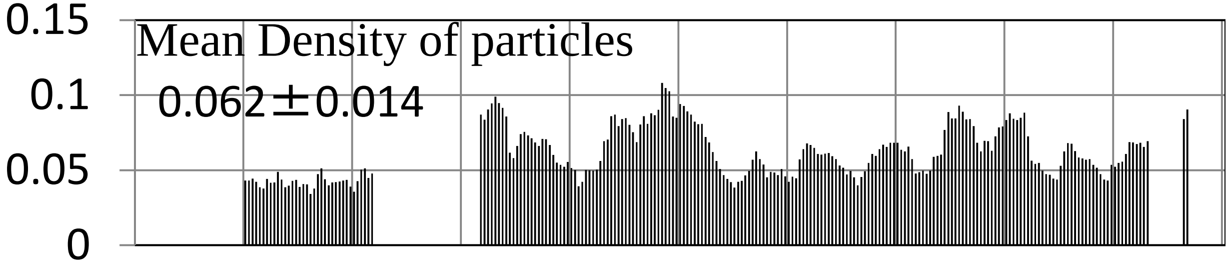
Mean density of snow particles

Density = Mass/Volume

Mass=Electro-balance/S

Volume=2DVD ($\Sigma D_{eq.}^3$)/A

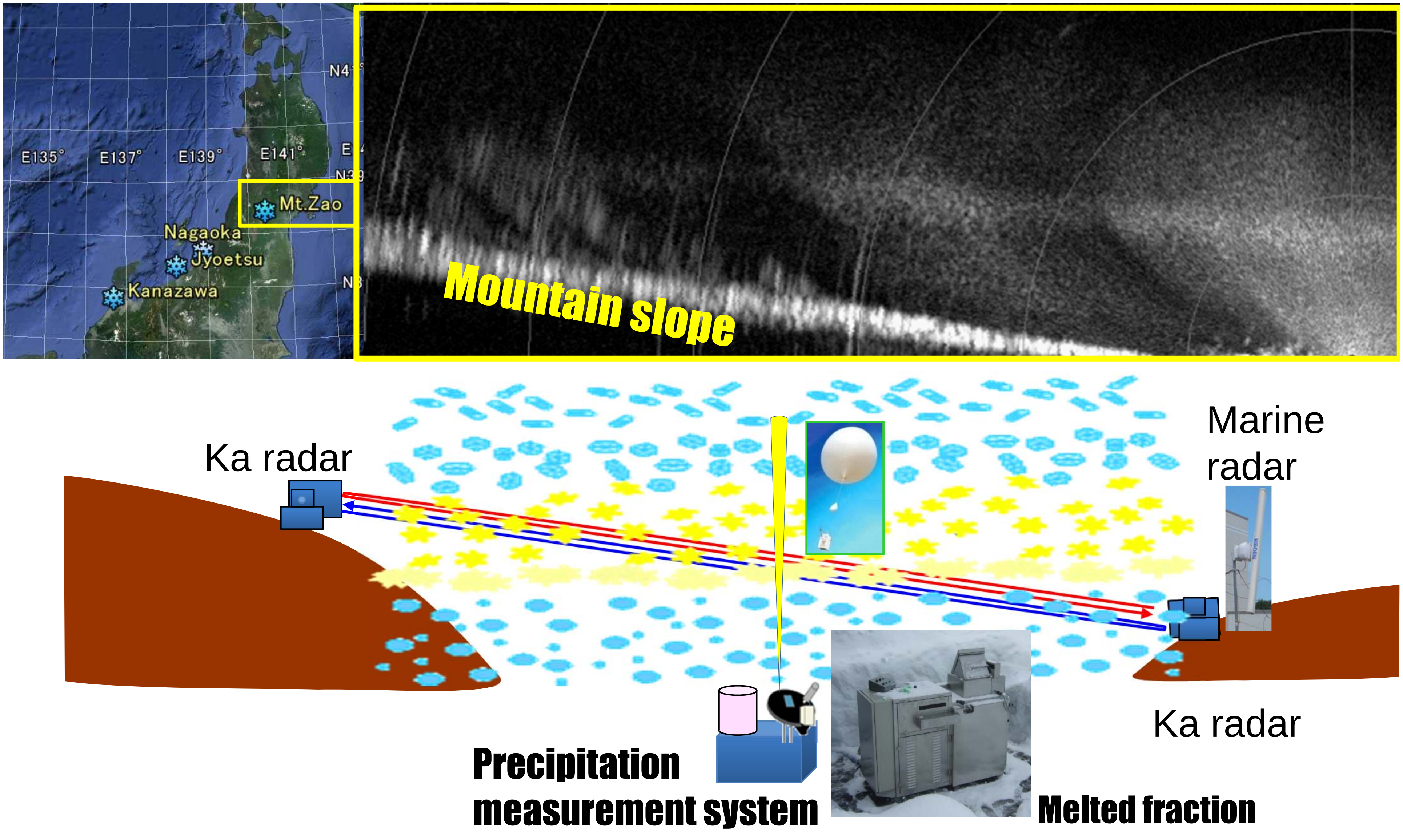




Densification of deposit snow,
Snow stratification & Abalanche
⇒ Snowpack Model

Ongoing study

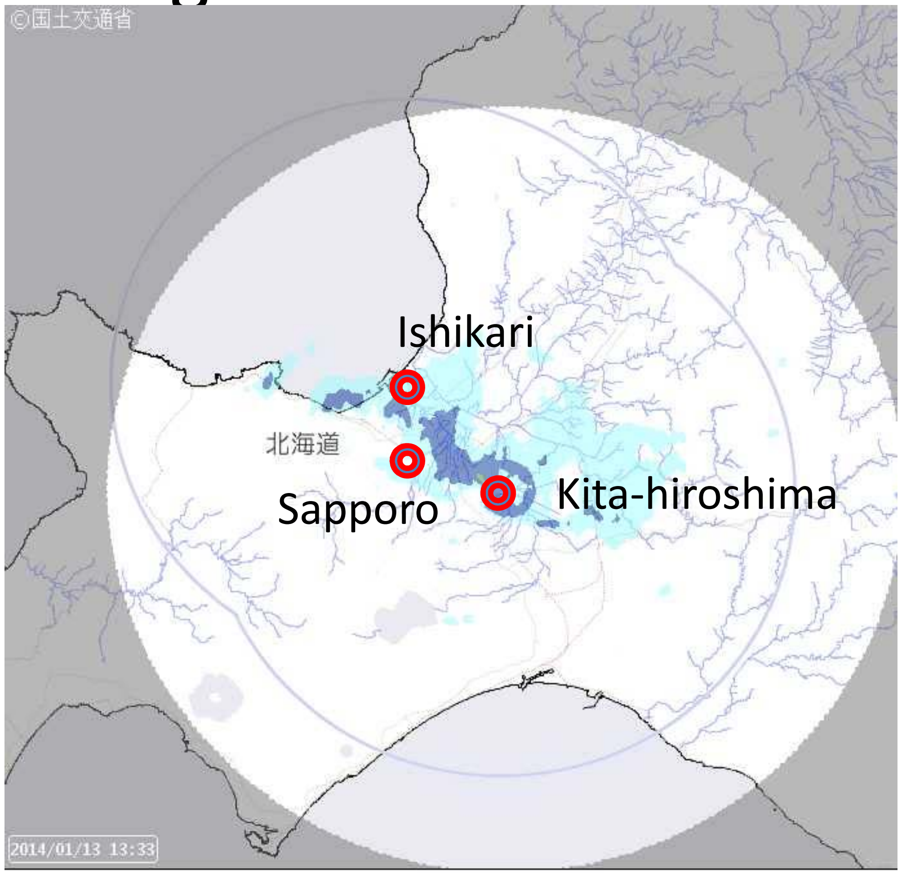
Useful to detect phase change of precipitation particles during field observation at Zao (Dec. 2013- Mar. 2014)



Mobile observation of snowfall

X-band MP radar

Range = 80 km



OTT Parsivel

Thank you for your attention

Z(K_a-radar) –Snowfall Intensity