P9.82

Time series of microphysical structure of a thundercloud examined with hydrometeor classification method for X-band polarimetric radar

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Introduction

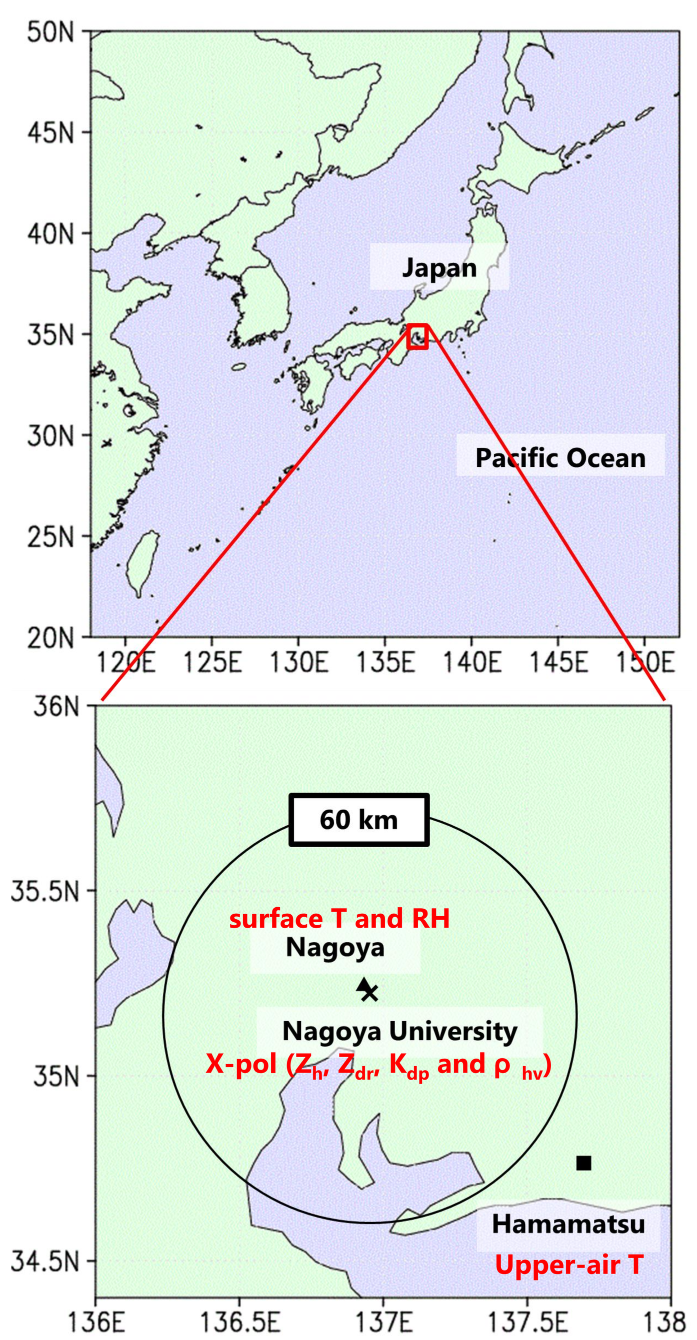
Polarimetric radars are useful instrument to obtain microphysical information and we have modified HC method for S-band polarimetric radar (S-pol) described in Liu and Chandrasekar (2000) to adapt to X-band polarimetric radars (X-pols) and **tried hydrometeor classification** (hereafter, HC) **with X-pols**. (Kouketsu and Uyeda, ERAD2010).

To evaluate the HC method, thunderclouds are useful target because **solid hydrometeors (snowflake, ice crystal and graupel)** are included and their relative locations in the cloud are closely related to the **polarity of lightning**. In this study, we targeted **a single thundercloud** of which we could observe **entire life cycle** in relation to **lightning polarity**.

Conclusions

- We conducted HC for **a single thundercloud** with the HC method tuned for X-pol and examined the **microphysical structure** of the cloud.
- The relation between the **volume of graupel (ice crystal) region** and the **frequency of negative (positive) CG** is **consistent with the polarity of CG** expected from the riming electrification process and, therefore, **our HC** method can be considered to **be reasonable for the single thundercloud**.

Data



▲ The location of the X-pol

Polarimetric Parameters
- Z_h (Reflectivity)
- Z_{dr} (Differential Reflectivity)
- K_{dp} (Specific Differential Phase)
- ρ_{hv} (Correlation Coefficient)

Meteorological Parameters
- Temperature (Surface and Upper-air)
- Relative Humidity (Surface)

HC → Drizzle, Rain, Wet Snow, Dry Snow, Ice Crystal, Dry Graupel, Wet Graupel, Small Hail, Large Hail, Rain and Hail

LLS Data
- Location of Lightning
- Polarity of Lightning

Comparison

Frequency		9375 MHz
Antenna size		2.0 m
Beam width		1.2°
Transmitter	Type	Solid state component
	Peak Power	200 W
Max range		61.8 km
Pulse width		1 μs (within 5 km) 32 μs (beyond 5 km, pulse compression)
PRF		2000 Hz / 1600 Hz (dual PRF)
Transmission		45° or H only or V only
Rotation rate		3.0 rpm (PPI) , 1.2 rpm (RHI)
Resolution		150 m
Nyquist velocity		16.0 ms^{-1} / 12.8 ms^{-1}

Characteristics of the X-pol ▲

Method

Data from the X-pol
- 150 m resolution
- 1.2 ° beam width

↓ Interpolation

Grid Data
- 0.5 km resolution

Meteorological Data

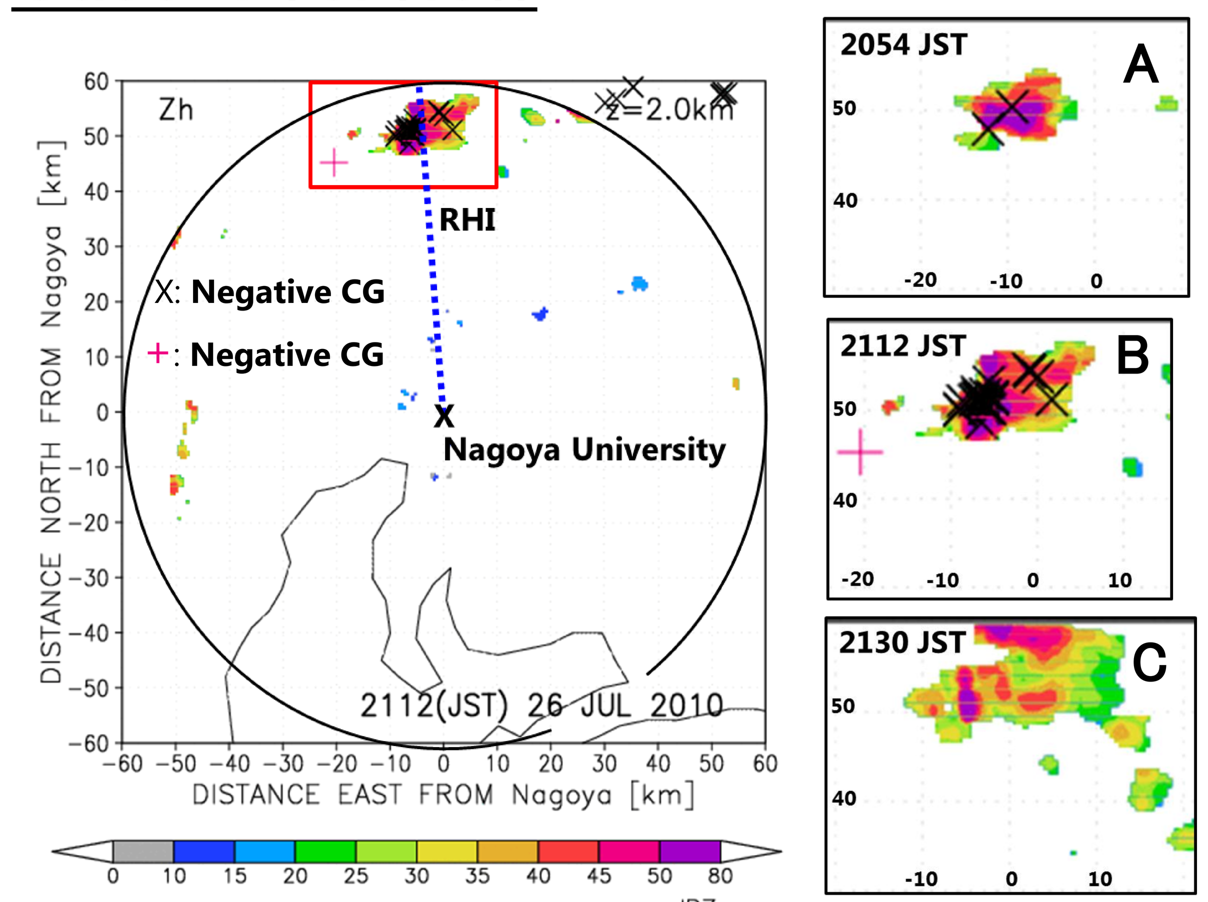
→ **HC method** (kouketsu and Uyeda, ERAD2010) →

Hydrometeor Type
- 0.5 km resolution
- 10 categories

↑ Summation

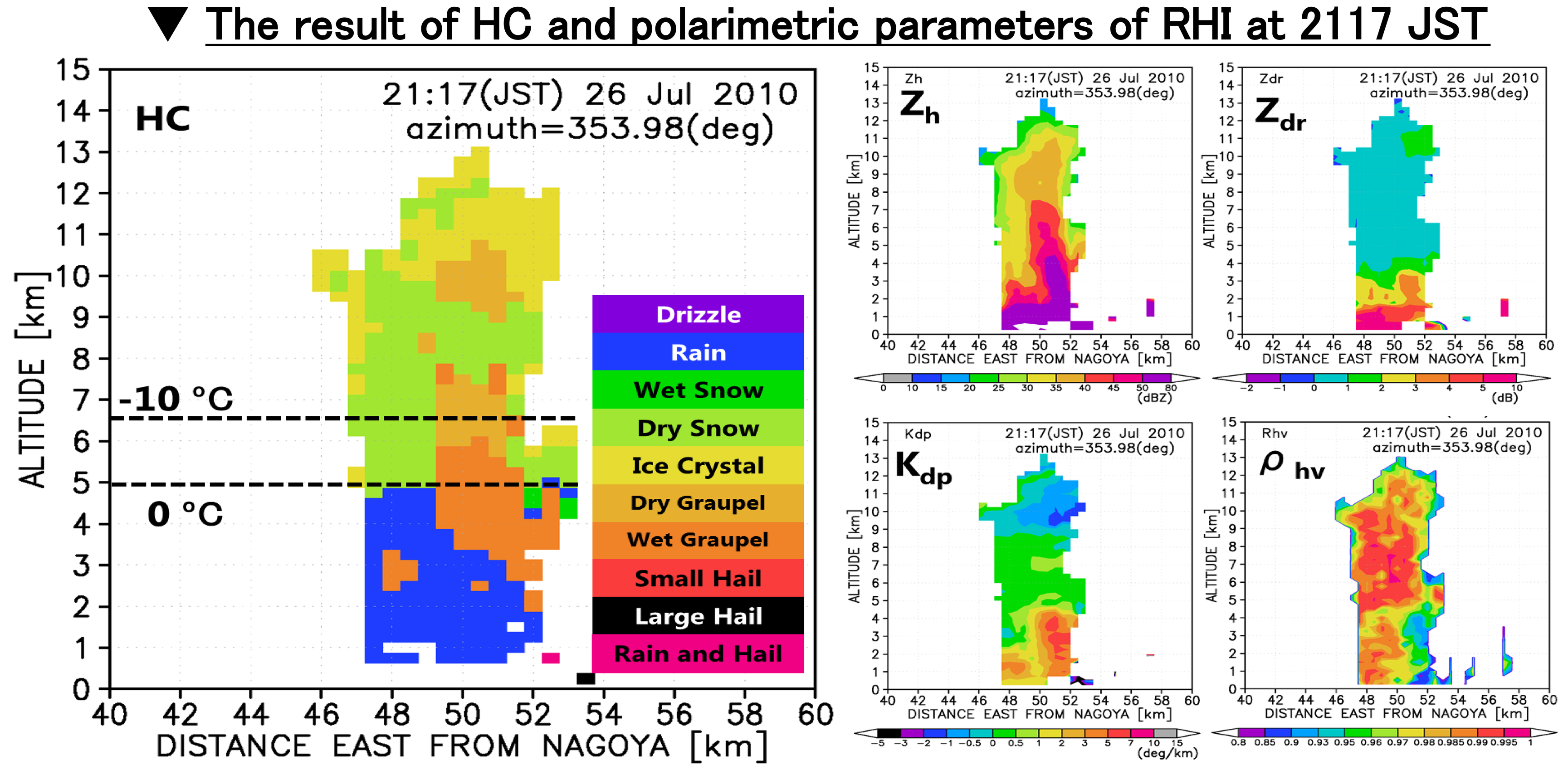
Volume of Region
- Ice Crystal
- Wet or Dry Graupel

Case Overview

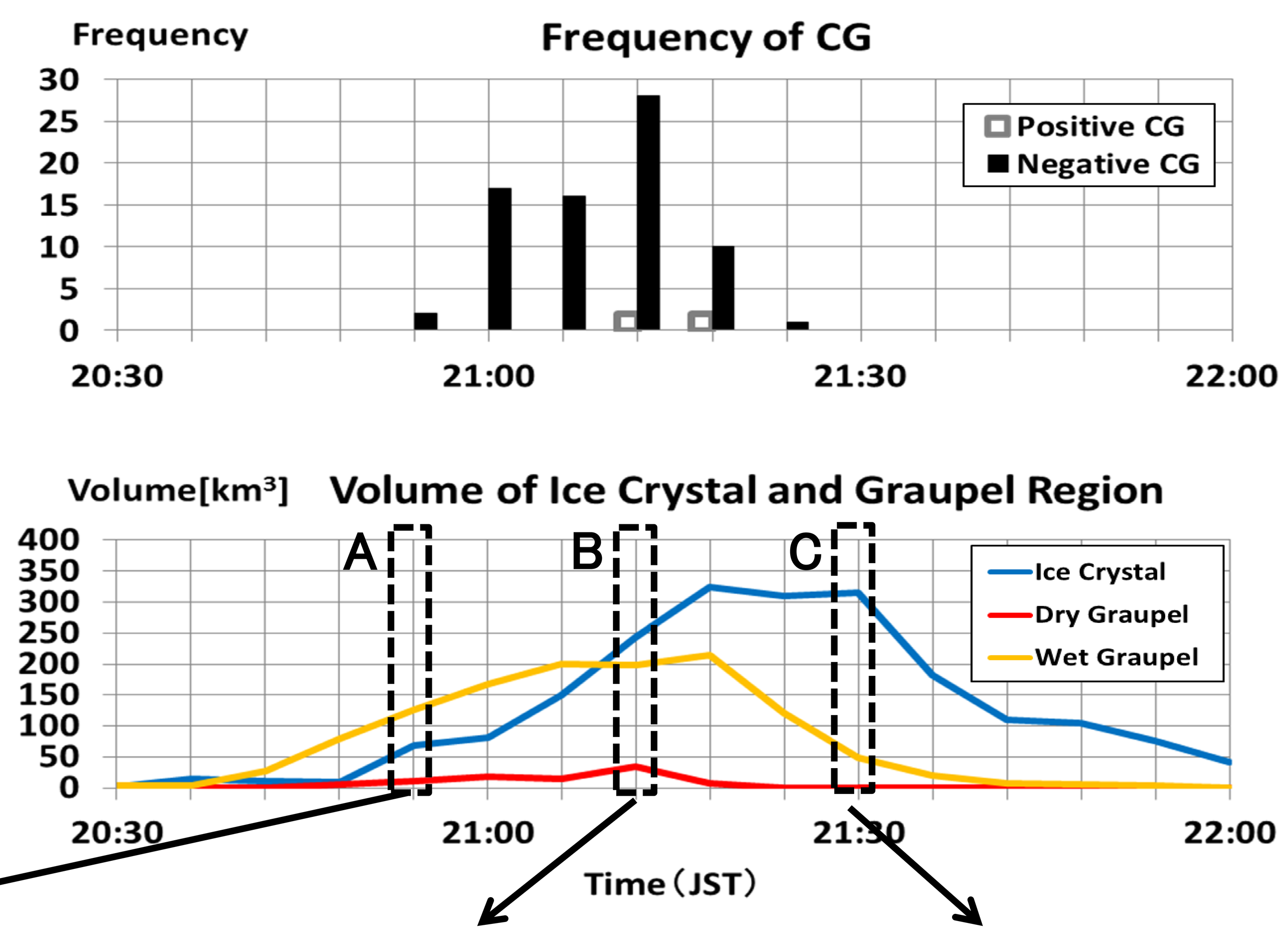


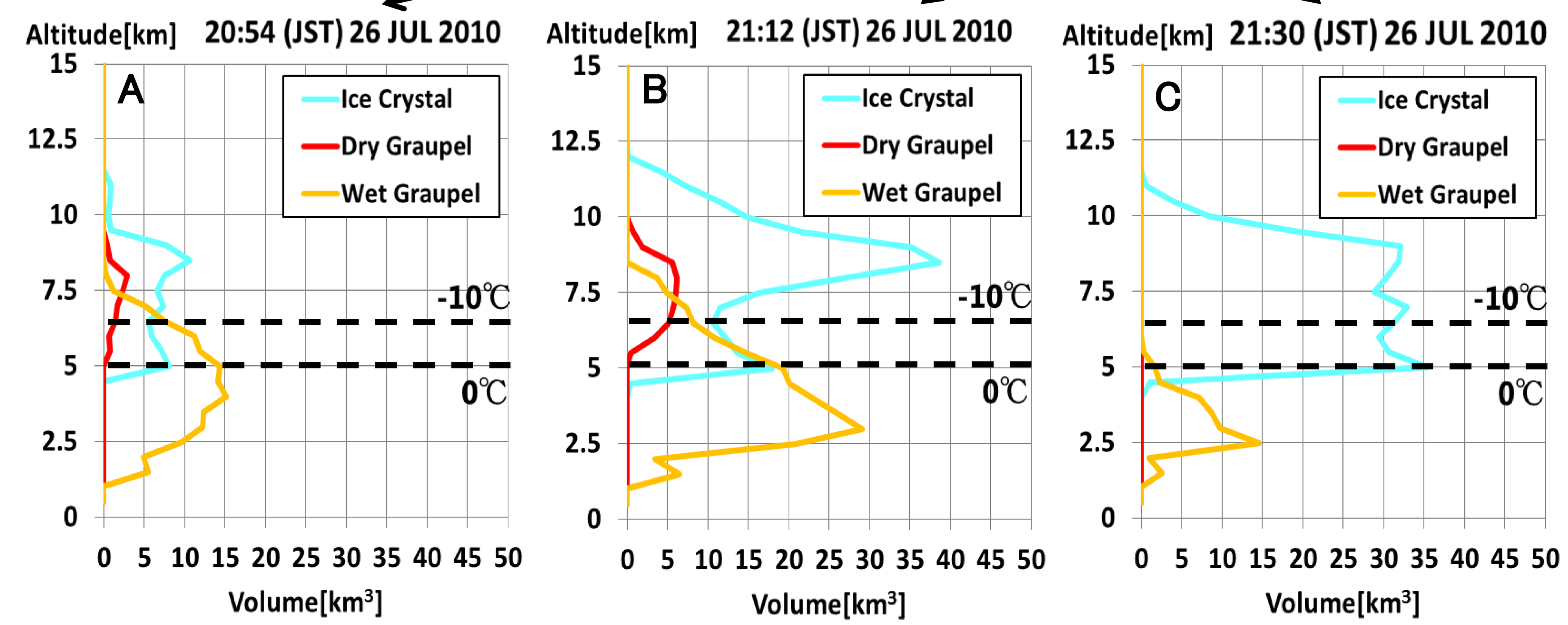
▲ Z_h at 2-km height at 2112 JST on 26 July 2010

▼ The result of HC and polarimetric parameters of RHI at 2117 JST



Result and discussion





▲ Vertical distribution of volume of hydrometeors ▲

- **Negative** CGs were observed only when there **was large volume of wet graupel** region (120 km^3).
- There was main dry graupel region around the height where the temperature was −10 ° C (6.5 km height) when many **negative CGs** were observed.
- When the volume of **ice crystal** region increased rapidly and reached the peak, **positive CGs** were observed.
- These facts are **consistent with the polarity of CG** expected from the riming electrification process (Takahashi,1978).