# Development of Hydrometeor Classification Algorithm for Korea Precipitation Systems

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## Introduction

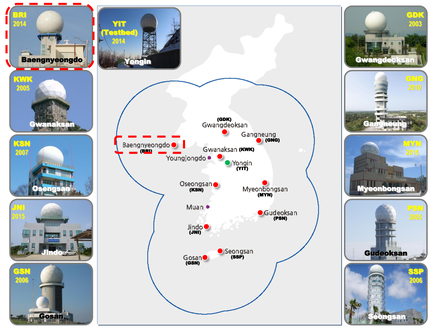
- Korea Meteorological Administration(KMA) has installed dual polarized radar since 2014. In addition there is a plan to replace exiting single polarized doppler radars to dual polarized radars until by 2019.
- The Weather Radar Center(WRC) in KMA is providing real time hydrometeor information, which is developed by National Center for Atmospheric Research(NCAR). However, this hydrometeor classification(HC) algorithm is not quite suitable for precipitation systems in Korea.
- We have improved a membership function of the HC algorithm based on NCAR technique and have develped a HC algorithm of 7 classes of hydrometeores including non-precipitation and 6 precipitation types.
- In particular, the classification increased as 3-Dimensional temperature data from KLAPS (Korea Lacal Analysis and Prediction System, WRF based weather prediction model developed by KMA) was used for high resolution of space and time.

## Data

### Radar Network of KMA

**Basic specifications of Baengnyongdo radar(BRI)**

| | |
|---|---|
| Manufacturer | EEC(U.S.) |
| Transmitting tude | Klystron |
| Band | S |
| Effective observational range(km) | 240 |
| Range resolution | 250 |
| Observation period (min) | 10 |
| Elevation angles ( ° ) | 0.19, 0.59, 1.00, 1.50, 2.19, 3.09, 4.30 ,5.80, 7.89, 10.80, 14.69, 20.00 |
| Anttena height(m) | 187 |

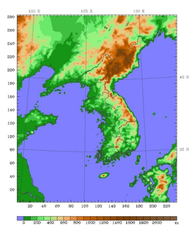



S-band dual-polarization radars will be replaced by 2019

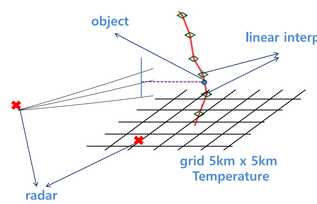
### Korea Local Analysis and Prediction System(KLAPS)

- space resolution : 5 x 5 km grid, 23 layer
- time resolution : 1hour

1. Select the grid point closest to the object to observe.
2. Interpolate two vertical temperatures closest to the point's height and use the value as temperature input data



<KLAPS analysis data field domain>




<KLAPS analysis data field vertical temperature profile>

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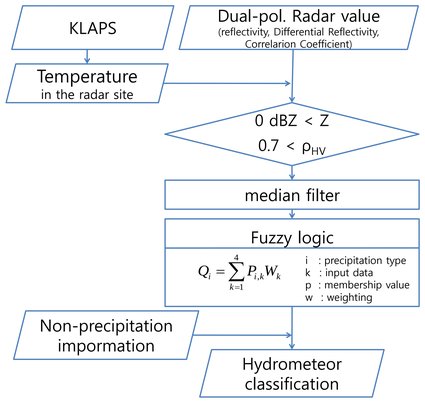
## Method

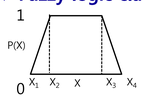
### Algorithm




**❖ Input data**

- Reflectivity(Z)
- Differential Reflectivity($Z_{DR}$)
- Correlation Coefficient($\rho_{HV}$)
- Temperature(KLAPS analysis data)

**❖ Fuzzy logic classifier**

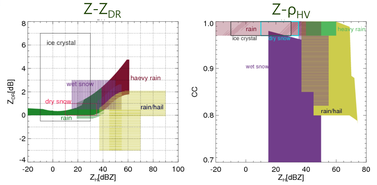



<membership function of trapezoid>

$$Q_i = \sum_{k=1}^{4} P_{i,k} W_k$$

P : membership value
W : weight
i : hydrometeor type

**❖ 2D membership function**

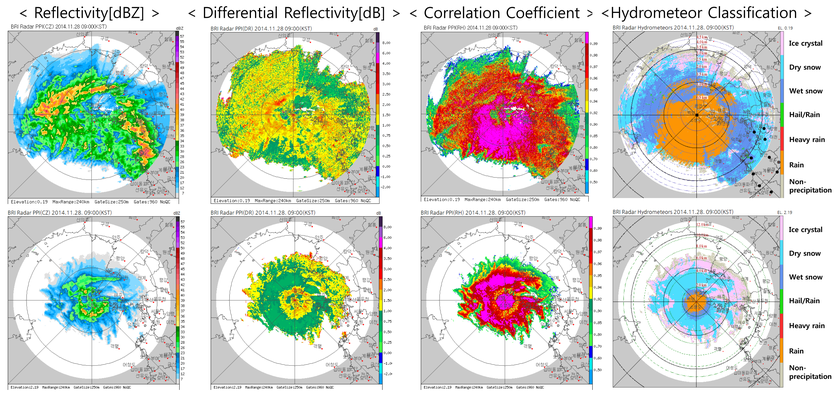


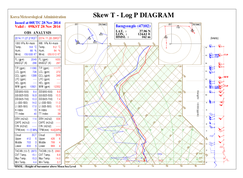

**❖ Hydrometeor types**

- Non-precipitation, Rain, Heavy Rain, Hail/Rain, Wet Snow, Dry Snow, Ice Crystal

## Result

### Case1, 00UTC 28 Novemver 2014 (Bright Band)

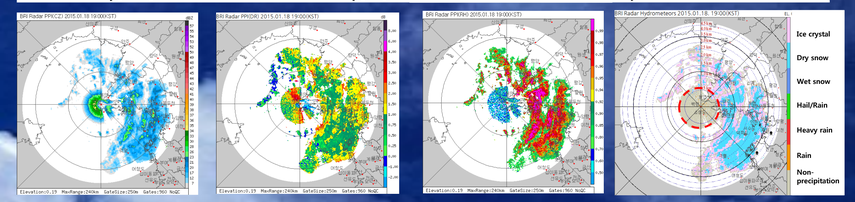



Baengnyungdo radiosonde

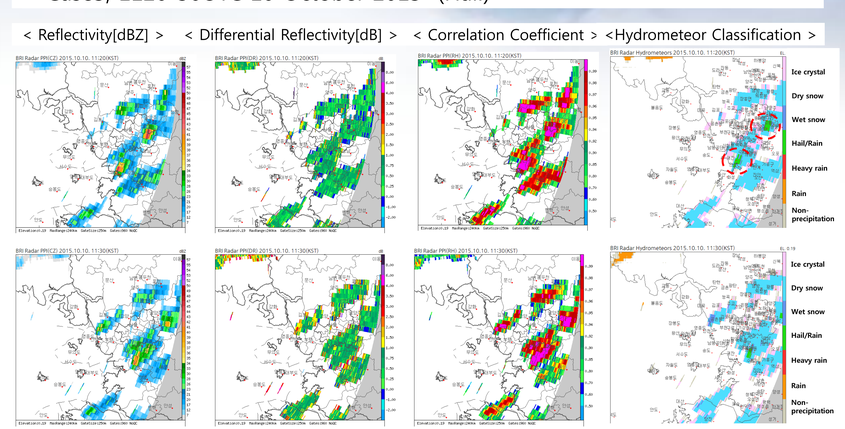
- symbol ● : rain on the surface
- Bright band (Z = 35~42dBZ, $Z_{DR}$ = 1~2.5dB, $\rho_{HV}$ = 0.9~0.95) is classified as wet snow.
- Wet snow is existed at about 1~2km in altitude. Within this area 0℃ of radiosonde is appeared at the height of 1.65km.
- The $\rho_{HV}$ value less than 0.7 at the edge of the precipitation echo is classified as non-precipitation.

### Case2, 10UTC 18 January 2015 (Snow & See Clutter)




- Snow : Z – 12~30dBZ, $Z_{DR}$ – 0.25~1
  ➔ HC : dry snow
- symbol ✕ : snow on the ground
  : sleet on the ground
- nearby radar site(red circle) : sea clutter
  ➔ HC : Non-precipitation

### Case3, 1120-30UTC 10 October 2015 (Hail)





<YTN News>

- Hail(diameter=1~2cm) was observed in the east of Seoul.
- The hail echo(Z = 40~48dBZ, $Z_{DR}$ = 0.25~0.75, $\rho_{HV}$ = 0.99)
  ➔ HC : Hail/Rain (red circle)
- Rain came down in the surrounding area of the region where hailed. However, HC algorithm is classified as snow because the radar observed it at a high altitude.

## Conclusions

- The purpose of this study is to provide categorized hydrometeor information for Korea Precipitation Systems using polarimetric variables gained from dual polarized radars to prove extreme weather detection and precaution.
- Hydrometeor classification algorithm were well matched with observation data from surface for the case of hail and bright band.
- Korean hydrometeor classification algorithm will be improved through more case studies using various types of precipitation, and the achievement will be contributed for real time weather forecast.