Enhancement of Korean Weather Radar Capability by Introducing a Dual-Pol Radar Network

Jeong-hee Kim, Jin-Gwan Yang, Seong-Heon Kim, Jong-Seong Kim

Radar Operation Division, Weather Radar Center, Korea Meteorological Administration, Seoul, Republic of Korea

(Tel +82-2-2181-0814, Fax: +82-2-833-0429, E-mail: jeongheek@korea.kr)

ABSTRACT

The Korea Meteorological Administration (KMA) is performing the Cross-governmental Weather Radar Integration, to facilitate and improve the efficiency of radar operation and the accuracy of weather forecasts by sharing radar data. To satisfy KMA's customer and fulfil cross-governmental administration, KMA is planning to introduce new generation dual-polarization radars(S-band) and establish radar test bed.

By introducing a new radar network and producing more reliable and various radar products, the WRC/KMA will strengthen national competitiveness and consolidate the basis of anti-disaster infrastructure.

Radar test bed will develop radar technologies in the field of operation, maintenance of radar, algorithm of data processing, personnel with training and technology of domestic manufacture. Introduction of new generation radar network and establishment of radar testbed will allow us to open a new era for weather service and industry in Korea.

1. Introduction

With increasing number of high impact weather phenomena, the level of dependence on radar data rises rapidly.

In response to users demand, the Korea Meteorological Administration (KMA) actively pursues the Cross-governmental Weather Radar Integration, a governmental program, to maximize the efficiency of radar operation and to upgrade the accuracy of weather forecasts by sharing radars run by several governmental organizations for different purposes such as weather forecasting by KMA, flood prevention by the Ministry of Land, Transport and Maritime Affairs (MLTM) and support for military operations by the Ministry of National Defense (MND).

In order to satisfy customer's needs and fulfill cross-governmental radar integration, KMA is performing two major tasks. One of them is introduction of new generation dual polarization radars(S-band single model), and the other is establishment of radar testbed as the same as new operational radar.

The conventional weather radar network helped weather forecasters to issue advisories for weather forecast since it has been established in 1969. However, we need to make improvements to live up to public's expectation since climate change and its relevant HIWs (high impact weather) has become social issues. Many of cities in Korea suffered lots of damages from sudden heavy rain and storms every year. KMA eventually decided to upgrade and develop the current radar network to meet the demand of the days.

2. Positive aspects and functions of dual polarization radar network

Current network consists of eight S-band and two C-band single polarization radars. KMA will replace current network with S-band dual polarization radars. The characteristic of new network is like as Table 1. New network will be compromised of 11 radars including ten operational radars and one testbed radar.

By introducing a new radar network and producing more reliable and various radar products, the KMA will contribute to national competitiveness and consolidate the basis of anti-disaster infrastructure.

In order to earn all radar data uniformly, the new radar system will be designed to have the same function and state of the art of specification with one manufacturer.

Table 1. Characteristic of S-band dual polarization radar in new network

Classification	Items	Performance
Radome	Attenuation	0.3dB or less(one way)
	Cross Polarization isolation	Exceed 55dB
Antenna	Horizontal and Vertical Beam width	1° in all planes
	Antenna gain	Above 44dB
	Scan speed	Max. 36°/s
	Cross-polar Beam	Cross Polarization Isolation in the main lobe is -33dB
	Polarization	Orthogonal linear simultaneous H/V Horizontal polarization mode for LDR
Dehydrator	Waveguide Pressure	Min. 3 psi(dry air)
	Overall Waveguide Loss	approximately 1.85dB
Transmitter	Frequency Range	2.7~3.0GHz
	Peak Power	850kW (VKS-8287 klystron)
	Transmitter power stability	within 0.3dB
	PRF Range	250Hz ~ 1,200Hz
Receiver	Receiver Type	Digital Receiver processing with separated H/V channels
Radar System	Signal Processing Gate	4000 Gates with gate spacing as little as 30 meters
	FFT(or DFT) Processing	FFT and DFT processing are available within the range of at least 240km for Doppler velocity mode

Starting installation of radar at Baengnyeongdo and testbed in the first half of next year, all radars will be deployed and changing the current radar network by the year of 2018 as plan in the figure 1.

Dual polarization radar has lots of capacity by the comparison with conventional weather radar. The most important function of it is particle identification. Snowfall, rain, hailstone will be distinguished from non-meteorological echoes such as chaff. Additionally, we have expected to improve capability of quantitative precipitation estimate.

Figure 1. Annual plans for replacement with dual polarization radar network.

In the table 2, dual polarization radar allows us to have many variables to assist weather monitoring. Obviously, dual polarization radar shows stronger performance than single polarization radar, however, in order to apply the operational function of dual polarization radar, development of techniques for data utilization is also important. National Institute of Meteorological Research(NIMR) of KMA has researched and developed a method for identification of hydrometeors and an algorithm for precipitation estimation by using X-band dual polarization radar for research.

Table 2. Comparison between Single Polarization radar and Dual Polarization radar

Classification	Single Pol Radar	Dual Pol Radar
Observation Variable	❖ Horizontal Reflectivity ❖ Radial Velocity, Spectrum width	❖ Horizontal, Vertical Reflectivity ❖ Radial Velocity, Spectrum width ❖ Differential Phase, Cross co-relation coefficient, Total Specific Differential Phase
Precipitation Estimate	❖ Reflectivity	❖ Reflectivity, Differential Reflectivity ❖ Reflectivity, Specific Differential Phase ❖ Reflectivity, Differential Reflectivity, Specific Differential Phase (Z-R relation error reduction 38% → 19%)
Quality Control	❖ Echoes characteristics	❖ Various Polarimetric variables
Identification Hydrometeors	❖ Insufficient to distinguish Hydrometeors	❖ Snow, Rain, Graupel, Hail stone, Ice Crystal ❖ Biological Echoes (Bird, Insect etc.)
Radar reflectivity Correction	❖ Hardware calibration ❖ Correction utilizing rain gauge	❖ Hardware calibration ❖ Correction utilizing gauge ❖ Self-Consistency correction method

KMA also should develop new algorithm and operational utilization program for new generation radar network. Particle Identification algorithm of NIMR as shown in Figure 2 will be applied to S-band dual polarization network after modification of S-band radar will be completed.

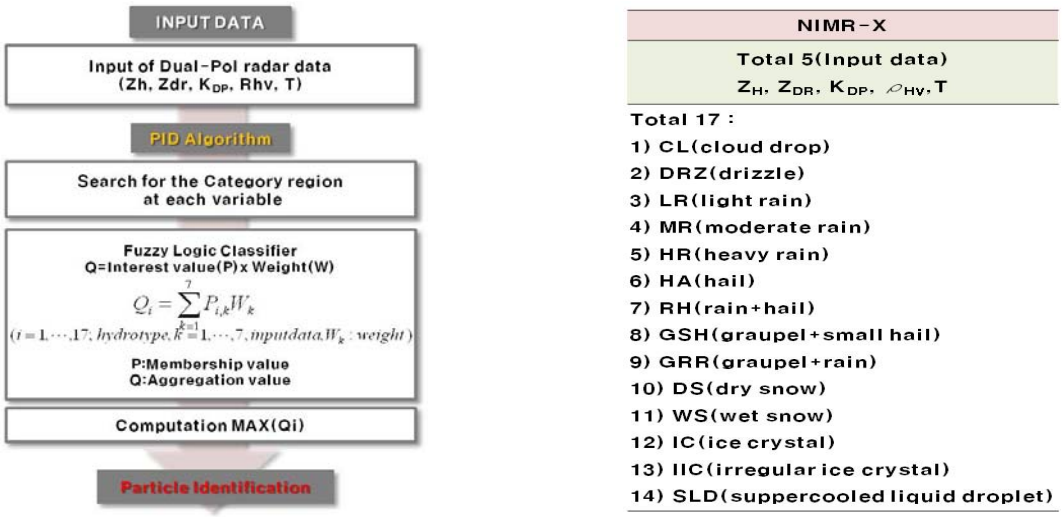

Figure 2. Particle Identification algorithm of KMA

We might conclude that identification of hydrometeors will provide high qualified weather information and contribute to upgrade the accuracy of forecast by the reason that dual polarization radars can observe precipitation precisely when the melting layer formed at low altitude in spring and autumn season.

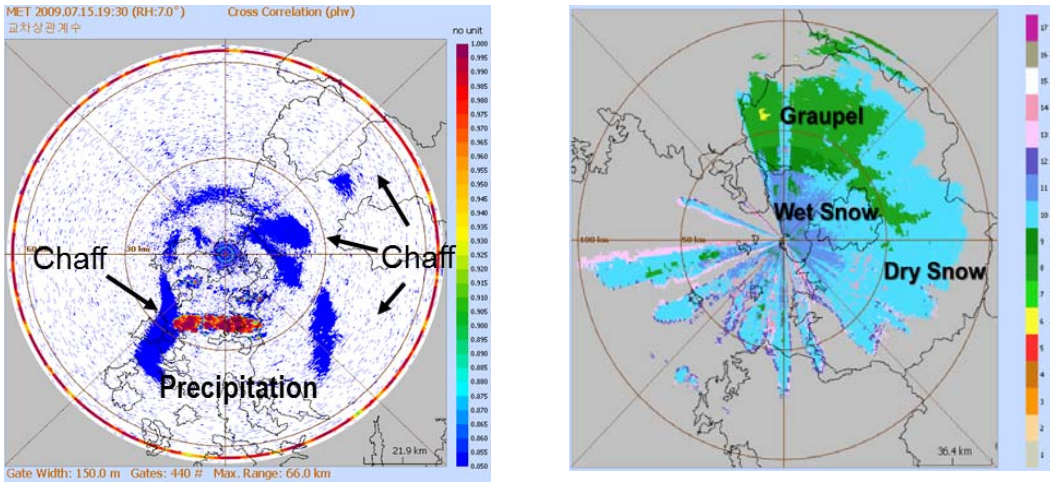

Figure 3. Identification of various echoes

3. Key role of radar testbed as a pivot on radar cooperation in Korea

With introducing new radar network, KMA also has a plan to establish radar testbed. It is needed for facilitating cooperative utilization of weather radar across multiple governmental agencies, KMA, MLTM, and MND. Testbed will be used by these agencies to collaborate in the field of radar observation, maintenance and data processing to improve the radar technology and data quality. Before this plan kicked off, a Memorandum of Understanding had been embedded in contract among these agencies. The ultimate function of the radar testbed will develop technology for operation and maintenance of radar and algorithm of data processing, manpower with training and technology of domestic manufacture.

Strategies on establishment of a radar testbed focus on a joint working system with other organizations, practical cooperation using meteorological science clusters, development of comparative observation program linked with standard weather observation and development of user-oriented radar data application programs.

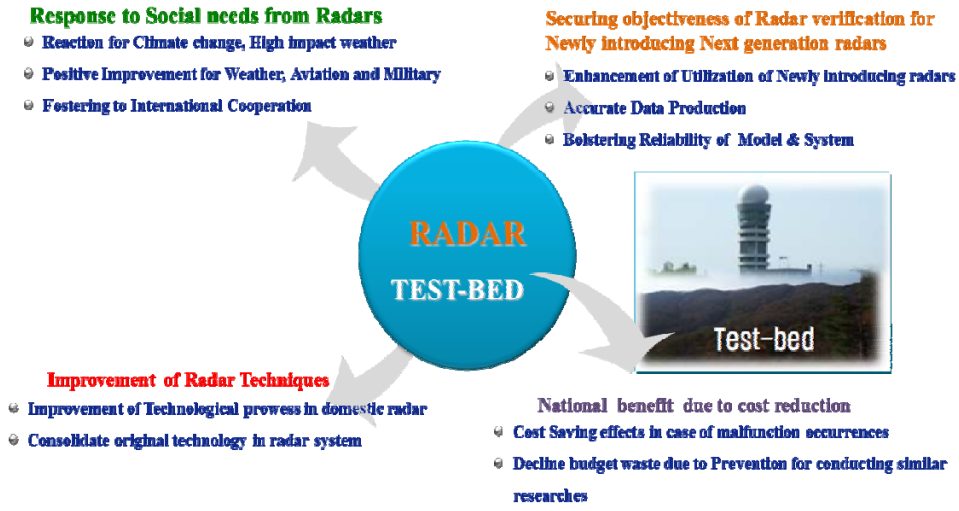

Figure 4. Expected effects of radar testbed

By using of radar testbed, we anticipate early stabilization of the next generation S-band dual polarization radar network and capacity building through cooperation among industry, academia, research and military.

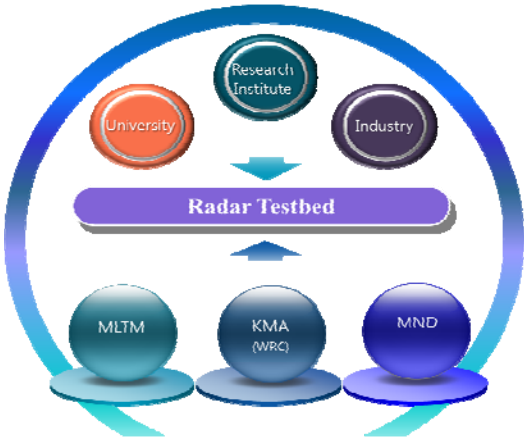

Figure 5. Radar testbed as a pivot for radar cooperation and development of techniques

4. Conclusion

KMA looks forward to raise and strengthen entirely the nationwide capability by securing advanced radar technology, providing high quality radar data to our customers and reducing the budget through introduction of S-band dual polarization radar with one model, establishment of testbed and cross-governmental radar integration project.