P3.46

Establishment of the SSPA X-band Dual-Polarization Radar Network over the Seoul Metropolitan Area

Ji-Young Gu, Sunjin Mo, Jinwoo Park, Sung-Hwa Jung, Kyung-Yeub Nam and Kunil Jang

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

1. Background and purpose

The Weather Radar Center (WRC) of the Korea Meteorological Administration operates ten S-band weather radars providing weather surveillance for public weather services. Almost all of them are installed on top of the mountain to minimize the radar beam blockage. To enhance the surveillance of low altitude hazardous weathers through the high temporal and spatial resolution, an X-band radar network is needed. Especially to detect the early stage of dangerous weather systems is very important in highly populated areas. Fig. 1 shows the main concept of this radar network.

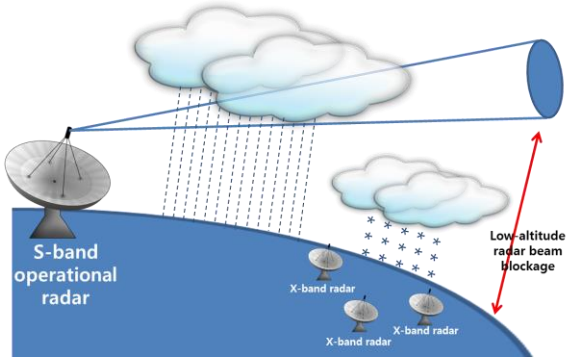

Fig. 1. Conceptual diagram of X-band radar network to minimize the low-altitude radar beam blockage.

2. Progress of radar installation

The plan of X-band dual-polarization radar network was drafted in 2015 and the installation began in 2017.

Corresponding author address : Ji-Young Gu, Weather Radar Center, Korea Meteorological Administration, Seoul, Republic of Korea;
e-mail: guji920@korea.kr or guji920@gmail.com

Even though this project started with a good purpose, but we encountered a problem. Many citizens complained of anxiety in radar installations due to electromagnetic waves near their residence. To solve this problem we had a thorough radar installation site selection process and had to go through enough discussions with the citizens.

The optimal locations of three radar sites were determined by the stepwise process including digital survey based on the digital elevation map and the GIS information, in-situ investigation, and the radio frequency survey. Table 1 shows the steps of this process.

Table 1. Stepwise process to determine the optimal location for the radar installation

Step	Procedure
1	Select the target area
2	Exclude the minimum blockage (>100 m)
3	Exclude the high altitude (<500 m)
4	Select the candidate sites using GIS information
5	Analyze the observation efficiency (>50%)
6	On site and radio frequency survey
7	Confirm the final locations
8	Cooperation with relevant departments

3. Specification of the radar

The radars that KMA installed for focusing the Seoul metropolitan area are the SSPA(Solid State Power Amplifier) X-band Dual-Polarization radars. These radars are operating with low

power (peak power is 1 kW) and using hybrid pulse and pulse compression techniques. The specification of these radars is described in Table 2.

Table 2. Specification of the radars

Frequency	9,345 MHz, 9,360 MHz
Wavelength	3.2 cm
Peak Power	1 kW
Pulse Width	1, 5, 78, 80 μs
PRF	500 ~ 2,000 Hz
Diameter of Antenna	1.8 m
Antenna Gain	42 dB
Weight of Radar	About 400 kg (Radome included)

The size of the radar is small and all elements including an antenna consist of one. Fig. 2 is photos of the radar and radome.

Fig. 2. Photos of the radar and radome.

4. Radar network over the Seoul Metropolitan Area

Three SSPA X-band radars installed in Deokjeok island, Mangil mountain, and Suri mountain. Fig. 3 shows the radar network and the observation coverage (observation radius is 90 km). Through this radar network, dangerous weathers developed over the western sea of Korea can be detected. Especially, to detect the early stage of dangerous weather systems is very important to minimize damages.

Fig. 4 shows real example of detecting the early stage of the heavy snow event occurred on December 28, 2018. At that time, the X-band radar network detected the low-altitude snow echo, but S-band operational radar network did not.

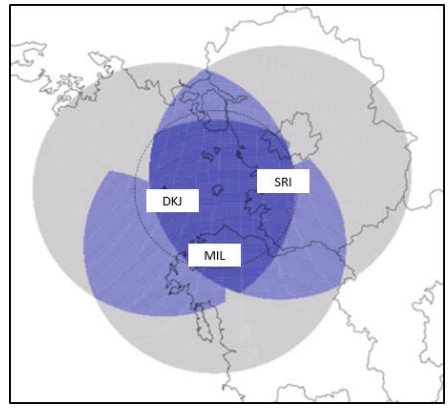

Fig. 3. SSPA X-band radar network and its observation coverage.

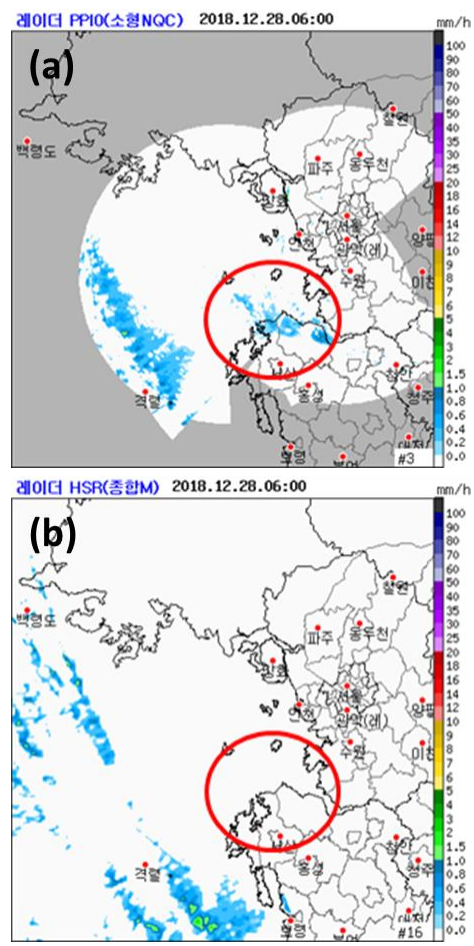

Fig. 4. Mosaic images of (a) SSPA X-band radar network and (b) S-band operational radar network on December 28, 2018.

5. Summary and future work

X-band radar network for compensating the operational S-band radar beam blockage is using in many countries. The WRC of KMA established SSPA X-band radar network over the Seoul metropolitan area. Through some case studies, the usefulness of X-band radar network is realized.

Despite many advantages of SSPA radars (small size, low cost, low power consumption, and easy maintenance), there are some challenges remained. Because these radars are using solid state power amplifier, the peak power is low. To fulfill the radar sensitivity and range resolution, hybrid pulse and pulse compression techniques have to be used. The hybrid pulse technique has some limitation as like the transition zone discontinuity between long pulse and short pulse. To reduce the discontinuity, special quality control algorithm is need. The WRC of KMA is developing the QC algorithm and testing it. Fig. 5 and Fig. 6 shows a sample of the minimizing the discontinuity in the transition zone of pulses.

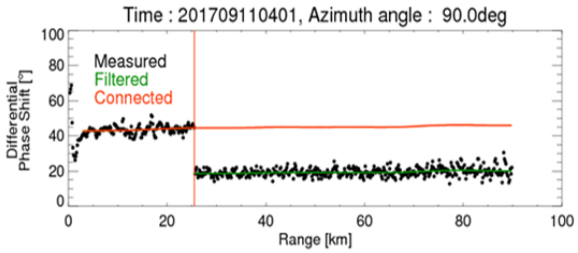

Fig. 5. Example of minimizing the discontinuity of differential phase shift in transition zone of two pulses(Courtesy of Jeong-Eun Lee).

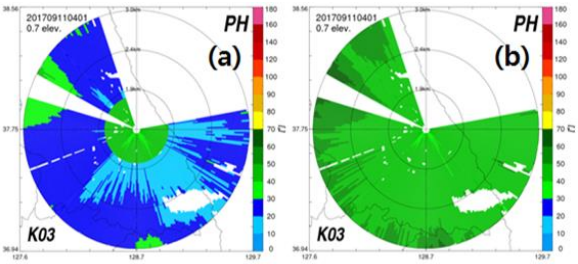

Fig. 6. Case study applied the minimization of the discontinuity of differential phase shift in transition zone of two pulses (Courtesy of Jeong-Eun Lee).

For effective operating SSPA X-band radar network, optimal scan strategy focused on low-altitude dangerous weathers and systematic data quality control are very essential. The WRC of KMA is developing the data QC algorithm and testing it. Through the algorithm, ground clutter and interference echoes were removed successfully.

To provide more useful radar data for weather forecasters, combining multi weather data and developing stereoscopic analysis application are planning to develop. Validation with real ground data also will be conducted in near future.

6. Acknowledgments

The research is supported by “Development and application of cross governmental dual-pol radar harmonization (WRC-2013-A-1)” project of the Weather Radar Center, Korea Meteorological Administration