1. INTRODUCTION

The importance to detect dangerous but small scale weather phenomena occurred in highly populated areas has increased because damages can be huge in these areas. In South Korea, weather radars are mostly located on top of the mountain to minimize the radar beam blockage. The Weather Radar Center of the Korea Meteorological Administration has installed three SSPA(Solid State Power Amplifier) X-band weather radars near the Seoul metropolitan area to enhance the surveillance of low altitude hazardous weathers through the high temporal and spatial resolution. The resident population within this radar network observation radius is twenty-eight million people which are more than 50% of the population in South Korea. The SSPA X-band radar network is operating with three elevation angles per 1 minute and the gate size is 150m. Fig. 1 shows the radar installation location and observation coverage of this radar network.

Fig.1 SSPA X-Band radar network and its observation coverage.

2. DETECTION OF SNOW

In this study, we analyzed two snowfall cases using X-band radar network. The first case is the snowfall occurred on December 28, 2018 from 00KST~13KST. Heavy snowfall recorded at Asan with 8.4cm and at Yesan with 4.5cm. At that time, the heavy-snow warning was issued in Asan and Yesan areas. Fig.2 shows the images of (a) precipitation type, (b) S-band operational radar mosaic, and (c) SSPA X-band radar mosaic on December 28, 2018. In this case, the X-band radar network detected the low-altitude snow echo, but S-band operational radar network did not.

The second snow case is the heavy snowfall event occurred on February 19, 2019 from 00KST~12KST in Seoul. Almost 5cm heavy snow was recorded in downtown area in Seoul. In this case also, heavy snow warning was issued. Fig.3 shows the images of (a) precipitation type, (b) S-band operational radar mosaic, and (c) SSPA X-band radar mosaic on February 19, 2019. In this case, the X-band radar network detected the low-altitude snow echo until the end of snow but S-band operational radar network did not. It means X-band radar network data can help to determine the ending point of the heavy snow warning.

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Fig. 3. Images of (a) precipitation type, (b) S-band operational radar mosaic, and (c) SSPA X-band radar mosaic on February 19, 2019.

3. DETECTION OF WATERSPOUT

Even though the waterspout phenomenon is not usual in South Korea, the fine-scale structure of waterspout was captured well by the X-band radar network. The waterspout occurred on March 15, 2019 in Dangjin-Si, Chungnam province. Some plants located near Dangjin-Si were damaged. Fig. 4 shows the locations of the point where the waterspout was observed (red dot) and AWS sites (blue dots).

Fig. 4 The locations of the point where the waterspout was observed (red dot) at 15:50 on March 15, 2019 and AWS sites (blue dots).

Table 1. AWS observation data near the point where waterspout was observed on March 15, 2019

<table>
<thead>
<tr>
<th>SITE</th>
<th>DATE/TIME</th>
<th>Wind Direction</th>
<th>Wind Speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyeon deok</td>
<td>3.15. 15:40</td>
<td>S</td>
<td>13.1</td>
</tr>
<tr>
<td></td>
<td>3.15. 15:50</td>
<td>S</td>
<td>13.1</td>
</tr>
<tr>
<td></td>
<td>3.15. 16:00</td>
<td>S</td>
<td>13.1</td>
</tr>
<tr>
<td>Sin pyeong</td>
<td>3.15. 15:40</td>
<td>S</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td>3.15. 15:50</td>
<td>SSW</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>3.15. 16:00</td>
<td>SW</td>
<td>9.7</td>
</tr>
<tr>
<td>Un pyeong</td>
<td>3.15. 15:40</td>
<td>SW</td>
<td>8.7</td>
</tr>
<tr>
<td></td>
<td>3.15. 15:50</td>
<td>SW</td>
<td>8.4</td>
</tr>
<tr>
<td></td>
<td>3.15. 16:00</td>
<td>WSW</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Fig. 5. S-band operational mosaic image at 1630KST on March 15, 2019.

Table 1 is the wind information (Automatic Weather System data) near the point where the waterspout was observed. Strong wind speed was recorded near the point.

Fig. 5 is the S-band operational radar mosaic image on March 15, 2019. In this image, any signals of waterspout did not represented. As mentioned in introduction, almost S-band operational radars are located on top of the mountain to minimize the radar beam blockage. It means very low-altitude weather system cannot be detected the S-band operational radar network.

Fig. 6. (a) X-band radar image on March 15, 2019 and (b) schematic diagram of the tornado generation.
In the comparison between X-band radar image and the schematic diagram in Fig. 6, the morphological similarity is found. The warm and humid airflow can be introduced into the rear side by the cold and dry air (RFD, Rear Flank Downdraft) and gust front occurred at boundary with area because the middle-scale low-pressure rotation is developed in the highly unstable situation (Bluestein and Golden, 1993).

Fig. 7 shows that the rotation component was continuously observed at the waterspout point indicated by the X-band weather radar image from 15KST to 18KST on March 15, 2019.

Fig. 7. Radial velocity images of X-band radar from 1544KST to 1549KST on March 19, 2019.

Fig. 8 is the comparison between X-band and S-band radar reflectivity and radial velocity on March 19, 2019.

4. Conclusion

The benefit of the X-band radar network is that it detects weak weather signals which can be developed into hazardous weather systems and observe them with a high time-spatial resolution. In this study, some cases have shown the benefit of the X-band radar network and we will continue to develop the technique for the detection of regional hazardous weather signals using the X-band radar network.

5. 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

6. Reference