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The examination of antenna performance for the calibration of Phased Array Radar

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In recent years, meteorological disasters caused by severe weather phenomena such as tornadoes and heavy rains occur frequently in Japan. In general, these disasters are caused by cumulonimbus clouds. It is very difficult to make observation of severe phenomena because they are developed within a few minutes. Weather radar is very helpful to observe those phenomena, however, the conventional radar, which has about 10 minutes temporal resolution and 500m spatial resolution, is not able to catch the detailed cloud growths and movements spatially or temporally. Thus, we have been developing the Phased Array Weather Radar (PAR) which is installed on the 13th floor rooftop of a building in Suita Campus, Osaka University, Osaka, Japan. PAR, which uses array antenna system, is provided with 128 slot antenna elements and generates multi-beam by means of digital beam forming. This feature enables us to track a great multiplicity of Doppler components due to rainfall. Therefore PAR has about 10˜30 seconds temporal resolution and is more suitable to observe severe weather phenomena than conventional radars.

In general, weather radar measures backscatter cross section of targets to make meteorological observations. We can know a weather condition by assigning it to radar equation. Radar equation includes radar constant which is determined by transmission power, transmission gain, receiver gain, and beamwidth; therefore we need to calibrate them to make the observation accurate.

In addition, each antenna elements of PAR has a bias error individually. the digital beam forming method cannot work well to form the received beam pattern. Therefore we take the bias error of each array into account when we calibrate PAR.

Here, we measured PAR's antenna pattern of transmitted and received beam to know actual gain and beamwidth. Furthermore, we measured the phase of the received signal, and compared it to the phase expected. From the result of the comparison, we calculated the bias error of each array and proposed the method of phase error correction.

Keywords: phased array radar, weather radar, array antenna, calibration