10.10 PRELIMINARY DESIGN STUDY OF AIRBORNE PHASED ARRAY WEATHER RADAR TARGETING THE TYPHOON OBSERVATION

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In this report, preliminary study of airborne phased array weather radar assumed to be installed in mid- to small-size jet aircraft (e.g. Mitsubishi Regional Jet, Gulf streamII, etc.) aiming for typhoon observation is shown. Airborne measurement has great advantages for typhoon observation because it is generated and developed over the ocean, and it is usually observed further than the range of ground-based radar observation. In the study, we first set requirements such as 3-D observation and wind observation in typhoon and constraint conditions from the aircraft set-up, then the feasibility to meet the requirements are examined.

Considering the size of typhoons, the observation range is set several tens of kilometres to several hundreds of kilometres in horizontal direction and near the ground to an altitude of more than ten kilometres in height. In the case of typhoons, it is required to observe the wall cloud surrounding the eye. Also, due to the performance of the aircraft, the flight altitude is confined about 12-13 km at the maximum, sometimes it is necessary to fly avoiding wall clouds reaching more than 15 km. Also, since the horizontal wind speed is the maximum in the low altitude near the wall cloud, the aircraft should observe from the high altitude outside the wall cloud. Furthermore, since the size of the antenna is limited due to attachment to the aircraft, it is about several tens of centimetres when it is attached to a pod, for example, or about 1 m when attaching it to the fuselage of the aircraft.

Based on these conditions and the maturity of radar technology, the basic specification was defined as follows: frequency is X-band or Ku-band, observation range is 30 km to 60 km, transmission power is about 400 W, and dual polarization is used. Although the radar can measure the velocity in the line of sight direction using the Doppler effect, movement of the aircraft is utilized to measure the wind field with the forward and backward beams. From the demands of 3-D observation and wind speed observation, it is necessary that the scanning angle is at least $\pm$ 20 degrees.

Considering the efficient observation taking the advantages of phased array technology, it is possible to observe two Doppler velocities with one antenna by switching beams between forward and backward direction. The beam direction is $\pm$ 30 degrees with respect to the direction orthogonal to the nose direction in this study.

Antenna scanning is also necessary for 3-D observations. For example, when conducting 3-D observation below the altitude of an aircraft, it is necessary to direct the antenna downward by 45 degrees and perform scanning of $\pm$ 45 degrees. Assuming that the pulse repetition frequency (PRF) of the radar is 2000 to 4000 Hz based on the observation range (30 to 60 km) and the number of pulse integration is 32, 0.9 seconds is required to cover the scanning range of 90 degrees assuming the elevation interval corresponds to the beam width.