

# The Development of the Ground-Based W-band Electronical-Scanning Cloud Profiling Radar with Digital Beam Foaming Technique for calibration and Validation of EarthCARE/CPR

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The Cloud Profiling Radar (CPR) is one of key sensors on EarthCARE, which is the joint satellite mission between Europe and Japan in order to measure three-dimensional distributions of aerosol and cloud and then to improve the understandings of Earth radiation budget. The EarthCARE/CPR is the first spaceborne Doppler weather radar to measure vertical velocity of clouds and precipitations. The National Institute of Information and Communications Technology (NICT) has developed the CPR in cooperation with Japan Aerospace Exploration Agency (JAXA).

NICT's contribution for the EarthCARE/CPR is not only hardware development but also the activity for the calibration and validation of CPR products. The requirement of minimum sensitivity of CPR is -35dBZ after 10km integration at the top of atmosphere and the requirement of maximum measurement error for Doppler velocity is 1.0 m/s (1.3m/s) after 10km integration for the uniform cloud which reflectivity is -19 dBZ. According to the study of Doppler velocity measurement from space, we understand that the horizontal non-uniformity of clouds in along track direction within radar footprint causes the significant measurement error in Doppler velocity.

The footprint of EarthCARE/CPR is about 750m on the ground, while the illuminated area of nominal ground-based W-band CPR is only about 100 m at 10 km height. In order to measure whole footprint of satellite CPR, ground-based CPR must scan the antenna beam. We decided to choose not mechanical scanning method but electronical scanning method because integration time must be maximized and scanning period must be minimized. Then NICT has developed the ground-based one dimensional electronical scanning CPR named ES-SPIDER for this purpose.

We selected the separate system of transmitting and receiving. The transmitting antenna has a fan beam with scanning direction in order to illuminate wide area and the receiving antenna has 32 antenna elements in scanning direction for phased array system. At the beginning, the radar system had only sequential scanning capability using phase shifters, and integration time was limited for fixed scanning period. Then upgrade was done to obtain 32 channels digital receiver. The antenna scanning is performed by the computation for synthesize various angles antenna beam adding phase information from the data obtained digital receiver, which called digital beam foaming (DBF) technique. Currently, the phase adjustment is not finalized, but example data is obtained. The status of development and initial result will be reported.

Keywords: EarthCARE/CPR, cloud profiling radar, phased array radar, W-band radar

## Image Example of Electronic-scanning Cloud Profiling Radar

