THE EXTERNAL CALIBRATION STUDY FOR EARTHCARE/CPR

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1. INTRODUCTION

EarthCARE, which is the joint program between Europe and Japan, provide for sensors and key sensor of them is Cloud Profiling Radar which is developed by National Institute of Information and Communications Technology (NICT) and Japan Aerospace Exploration Agency(JAXA). CPR is Doppler radar using 94GHz. In order to achieve sensitivity of -35dBZ at top of atmosphere, antenna scanning capability is not implemented. The difficulty of external calibration of ground is expected due to small foot print less than 1km. In this paper, the external calibration study is reported using CloudSat data. CloudSat is operated more than three years and normalized radar cross section (NRCS) data for land and ocean are provided in their level 1b data.

2. THE METHOD OF EXTERNAL CALIBRATION

The external calibration can be performed with calibration target with known normalized radar cross section (NRCS). As the calibration target, we consider active calibration target and natural distributed calibration target.

2.1. External calibration using known active radar calibrator

Instead of corner reflector as calibration target, active radar calibrator (ARC) can be used. The ARC measures received power and shape from transmitting power from satellite and transmits the same or similar pulse from ground with accordance with fixed time shift in order to distinguish from intense ground scattering.

2.2. External calibration using natural distributed target

The NRCS of sea surface is known according with wind velocity over ocean. When incidence angle is near nadir, the NRCS is accordance with quasi-optical scattering theory [1]. The scattering property of sea surface by W-band frequency is measured using NICT's airborne cloud radar (SPIDER) and the result can be used.
There is no available information of land surface NRCS for W-band frequency other than the data obtained by CloudSat. Statistical information of land surface is not reported, but it is expected to use for attenuation correction due to water vapor and cloud liquid water. The information from CloudSat is considered to be useful.

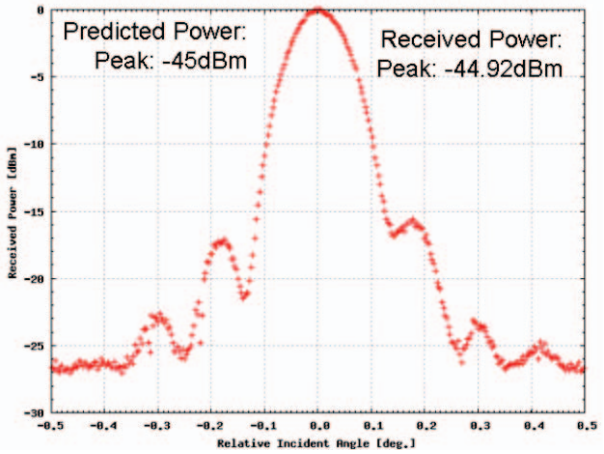

Figure 3 The Reconstructed Antenna Pattern

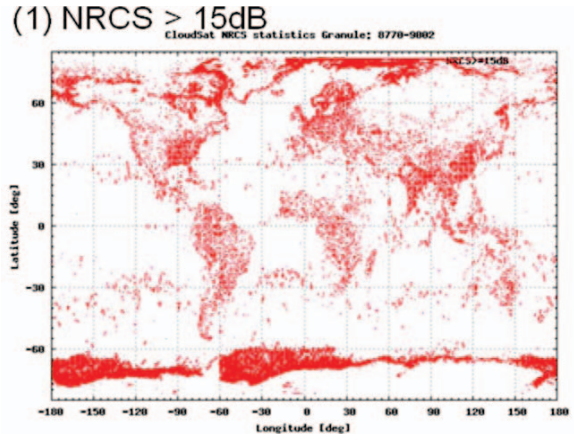

Figure 4 CloudSat NRCS Data larger than 10dB for one returning cycle.

3. EXTERNAL CALIBRATION USING ARC

The known issues for external calibration using ARC is following items.

1. Accurate Prediction of satellite sub-track and passing time over the location, in advance
2. Accurate Placement of ARC at predicted position and starting data acquisition on predicted timing

In order to examine above items, the preparation experiment using CloudSat was performed. Due to limitation of regulation and independent activity to CloudSat team, only receiver function instead of ARC was performed. The receiving signal from CloudSat was succeed. Figure 3 shows constructed antenna pattern from this experiment. The issues listed above are considered to be solved. The condition of satellite track prediction will be required to EarthCARE operation team.

4. EXTERNAL CALIBRATION USING NATURAL DISTRIBUTED TARGET

The NRCS of sea surface is measured by SPIDER and the empirical relationship will be established from them.

The dataset for land surface NRCS is not available. Statistical analysis is started using CloudSat Level 1b data. Figure 4 shows the NRCS data larger NRCS than +15dB, which is considered as saturated level of EarthCARE/CPR receiver. It shows only for one returning cycles, but it may not be used for data correction. We have to consider the area which has less possibility to use data correction.

5. CONCLUSION

The study for the external calibration method is reported. The method using ARC and sea surface NRCS are considered as major calibration target. The method using land surface NRCS is necessary further study.

REFERENCES

[1] G. R. Valenzuela, “Theories for the interaction of electromagnetic and ocean waves – A revise,” *Bound. Layer Meteorol.*, vol. 13, pp. 61-85, 1978.