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ESTIMATION OF LIQUID WATER CONTENTS BY THE DUAL-FREQUENCY CLOUD RADAR

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1 INTRODUCTION

The dual-frequency cloud radar, a part of Mobile Multi-parameter Radar System we have recently developed, uses a single Cassegrain antenna with 2 m diameter both for the Ka-band and the W-band subsystems. Therefore, the Ka-band and the W-band radars can observe the same direction. In order to utilize this characteristic, we plan to measure liquid water contents (LWC) of clouds by the dual-wavelength method. In this paper, we examine the performance of LWC measurements by computer simu-lations.

2 MEASUREMENTS OF LIQUID WATER CONTENTS BY THE DUAL-WAVELENGTH METHOD

Attenuation of a millimeter-wavelength radio wave by a cloud is relatively high, and therefore compensation of the attenuation is one of the major problems of millimeter-wavelength meteorological radars. Since attenuation by clouds is proportional to the LWC, and the attenuation coefficient depends on a radio frequency, the LWC can be estimated from the ratio of echo powers observed with two wavelengths [1].

3 RESULTS OF SIMULATION

Table 1 is the specification of the radar model used in the computer simulations, which is based on the actual radar system. Figure 1 shows a meteorological model used in the simulation. This model consists of 2 horizontal layers; layer 1 is a clear-air layer and layer 2 is a cloud layer.

Figure 2 is a result of computer simulation. As shown in graph (a), LWC is 0.5 g/m^3 and the height of the cloud bottom is 1km in this simulation case. Figure (b) and (c) show simulated signal to noise ratio (SNR) on a vertical section for the Ka-band radar and the W-band radar, respectively. Figure (d) is a distribution of estimated LWC, and figure (e) is a standard deviation of the estimation. From this figure, LWC is accurately estimated up to 2.2 km altitude and 1km horizontal range.

Figure 3 shows a relationship between the bottom height of clouds and accurately observable depth of the clouds. This result indicates that the observable depth of the clouds is about 1 km if the height of the cloud bottom is 3km, liquid water content is 0.5 g/m^3 .

4 CONCLUSION

In this paper, we examined performance of LWC measurements with the dual-frequency cloud radar we have developed by computer simulations. The actual performance of the radar system will be verified by field data in the near future.

References

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Table 1. Simulation parameters.

	Ka-band	W-band
Frequency	35 GHz	95 GHz
Peak power	100 kW	1.5 kW
Antenna diameter	2 m (common antenna)	
Antenna gain	52 dB	58 dB
Antenna scan	0.5 rpm	
Beam width	0.4 deg.	0.2 deg.
Pulse width	0.5 micro sec.	1 micro sec.
Noise Figure	5.0 dB	8.0 dB

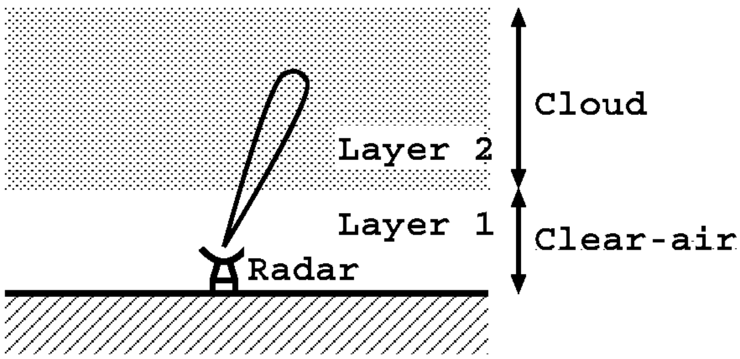

Figure 1 Outline of the simulation model.

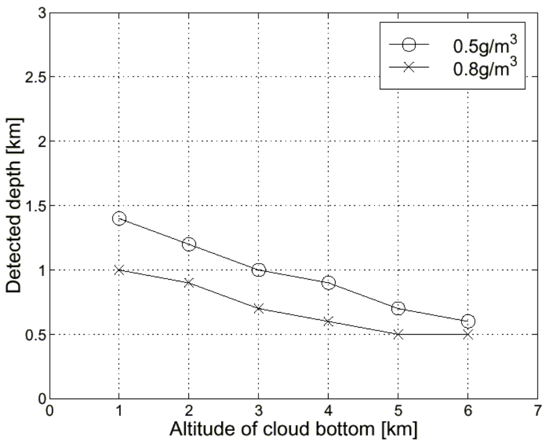

Figure 3. Observable depth of clouds.

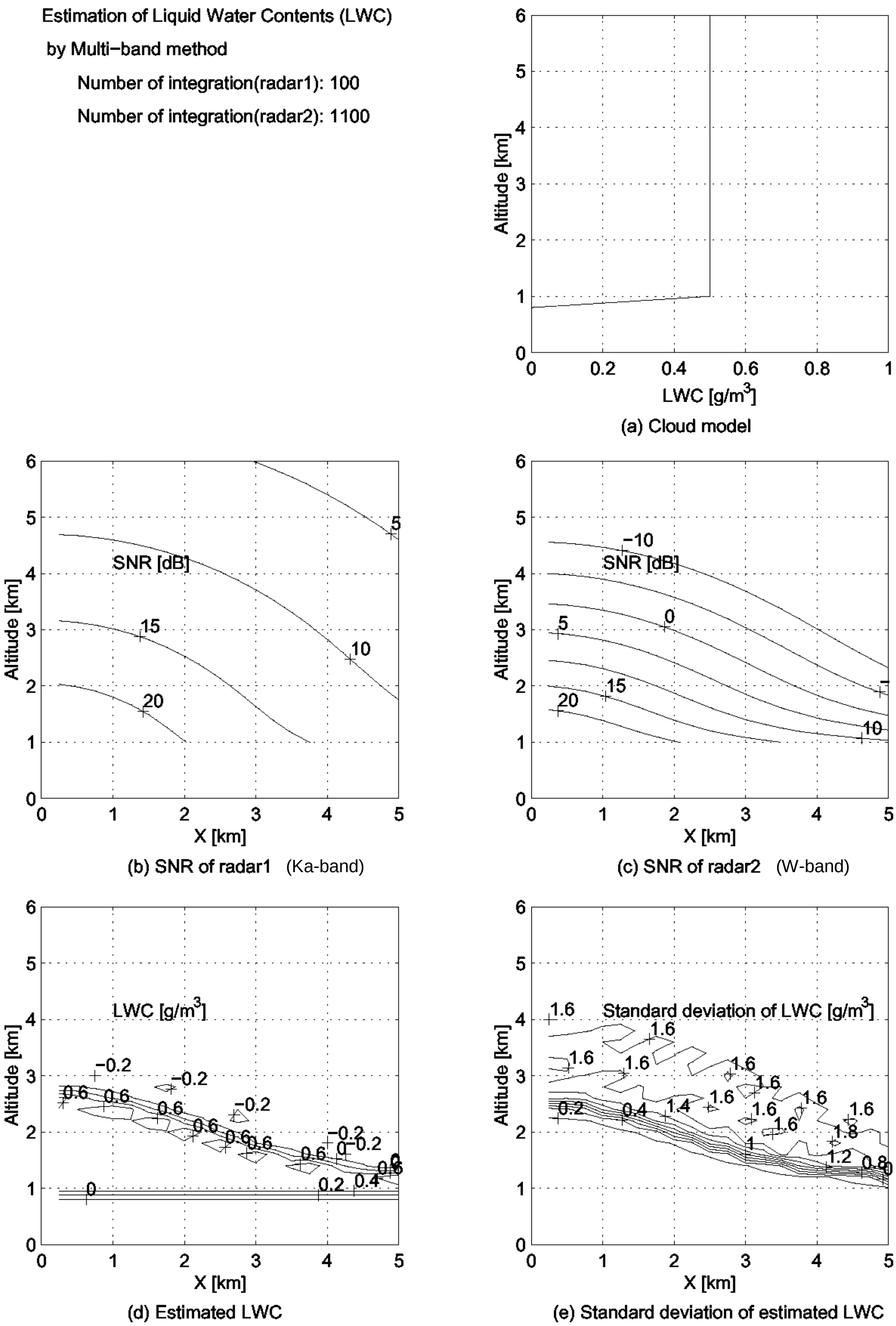

Figure 2. Simulation results of estimating liquid water contents.