A BAYESIAN APPROACH FOR PRECIPITATION ATTENUATION CORRECTION WITH A Ku-BAND BROAD BAND RADAR NETWORK

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1. INTRODUCTION

It is difficult for conventional long range radar systems (range resolution of about 100m and temporal resolution of about 5 min) at S-, C-, and X-band to detect small scale phenomena such as tornadoes and downbursts, whose horizontal scale is several hundred meters, and whose duration is several minutes. We has developed a meteorological Broad Band Radar (BBR) at Ku-band (range resolution of several meters and temporal resolution of about one minute (Yoshikawa et al. 2010 [1])). And we have advanced a weather radar network consisting of several BBRs With this network system, in overlapped area, weather phenomenon is observed simultaneously and multilaterally by multiple BBRs, and even if one BBR is affected seriously by precipitation attenuation and measured reflectivity with this BBR is underestimated, another can observe the same precipitation event from different view with low attenuation. We can integrate measured values from each BBR and calculate more accurate values. And precipitation attenuation correction at Ku-band can be accomplished accurately and stably.

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2. New retrieval method

Now, we have developed the radar network system consisting of three BBRs in North Osaka area in Japan, and we also have been developing a new retrieval method for precipitation attenuation at Ku-band under the condition of network observation with several BBRs. This method adds Bayesian theory to the HB method (Hitschfeld and Bordan, 1954 [2]), and optimizes the attenuation coefficient and radar reflectivities.Fig.1 indicates the flow diagram of our method. And the adaptively-optimized value of the coefficient can be derived by minimizing the cost function. This means the maximization of the product of likelihood functions of each radar.

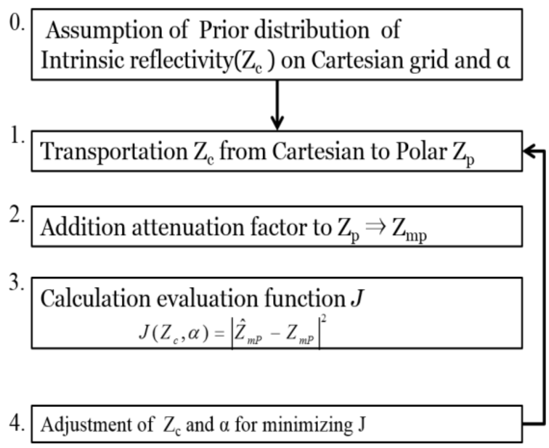

Fig.1 Flow Diagram of our method

3. Simulation

3.1 One dimensional simulation

Fig.2 shows a one dimensionl simulation result of our method. The horizontal axis means range and two radars are set at each end. The vertical axis means reflectivity. The black and red lines indicate precipitation model and estimate value, respectively. We can get the value of standard deviation between the truth and estimated value, 1.7 [dB].

3.2 Two dimensional simulation

Fig.3 indicates a two dimensional precipitation model, and two radars are located at (7,0) and (-7,0). Fig.4 shows the result of our method, and Fig.5 shows the result of HB solution. These indicate that we can retrieve precipitation attenuation stably, and with the HB method, on the other hand, in area far from BBRs, the value of radar reflectivity is overestimated. In Fig.4, however, the shape of precipitation core strains. We have some problems about our method to decide weight values from the Cartesian to the Polar grid.

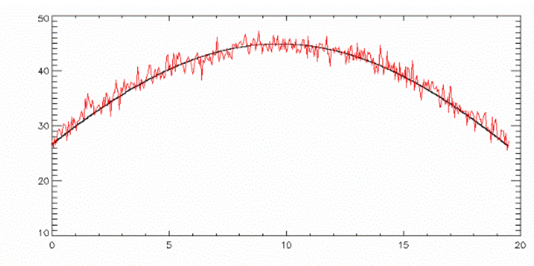

Fig.2 1D Simulation Result

(Black: True value, Red: Estimated value)

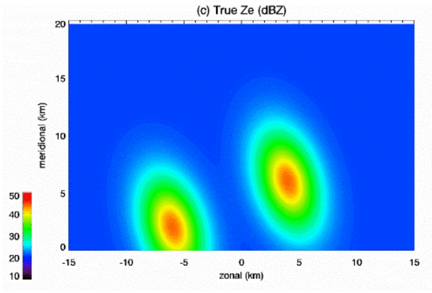

Fig.3 2D Simulation Model

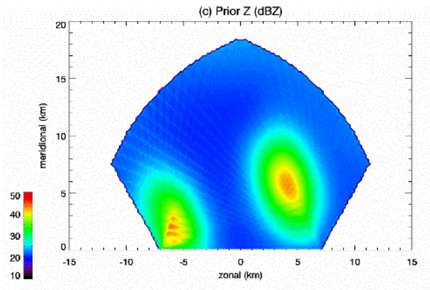

Fig.4 Result of Our Retrieval Method

on 2D Simulation

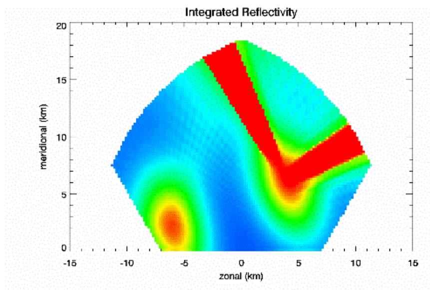

Fig.5 Result of HB Method

on 2D Simulation

Reference

[1] E. Yoshikawa et al., Development and initial observation of high-resolution and volume-scanning radar for meteorological application, IEEE Trans. Geosci. Remoto Sens., vol. 48. no. 5, 2010.

[2] Hitschfeld, W. and J. Bordan, 1954: Errors inherent in the radar measurement of rainfall at attenuating wavelengths. *J. Meteor*.