MEASUREMENT AND ANALYSIS OF PADDY FIELD BY POLARIMETRIC GB-SAR

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1. INTRODUCTION

Nowadays, polarimetric synthetic aperture radar (SAR) technology such as satellite SAR of ALOS/PALSAR and TerraSAR-X gathers much attention. And, vegetation monitoring is one of the interesting applications of them. This paper presents a polarimetric radar measurement in a paddy field with a ground-based SAR (GB-SAR) system [1]. Particularly, we focus on a polarimetric behavior due to an ear emergence of the rice.

2. POLARIMETRIC GB-SAR SYSTEM

Our GB-SAR system is a stepped-frequency radar system which employs a vector network analyzer to measure a scattering information in a frequency domain. A dual ridged horn antenna is used as a transmitting and receiving antenna, so that full polarimetric characteristic can be measured. One difference from conventional SAR system is a size of an antenna aperture. Although it is possible to acquire data along a very long survey line with an airborne and a spaceborne SAR, GB-SAR has a limitation of the scanning aperture. So far, we have been carried out GB-SAR measurements with a purpose of tree monitoring, cliff monitoring and so on.

3. MEASUREMENT IN PADDY FIELD

In this paper, we focus on a growth of a rice plant, and carried out GB-SAR measurement in a paddy field. The paddy field of Miyagi Prefectural Furukawa Agricultural Experimental Station, Japan [2] was selected as a test site. A measurement scenery can be found in Figure.1. One important thing here is a timing of the measurement, a measurement dates are

Figure.1 GB-SAR measurement in a paddy field

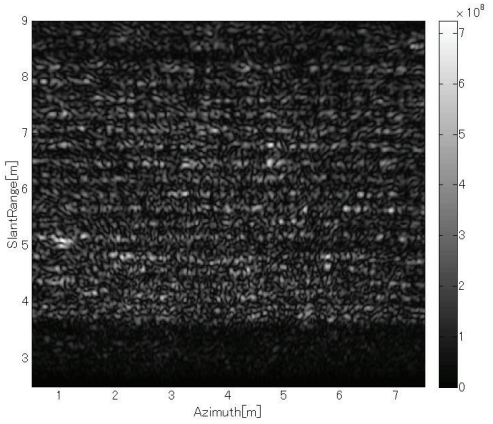

Figure.2 Reconstructed image of the paddy field

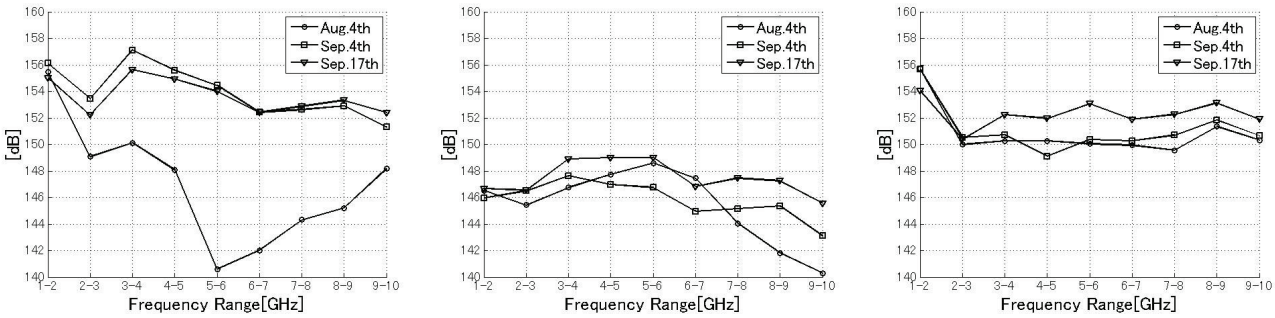

Figure.3 Image intensity as a function of frequency range for (a) HH, (b) HV and (c) VV components.

Aug.4th, Sep.4th and Sep.17th in 2008. A condition of the rice plant is different between Aug.4th and others. An ear of the rice did not appear on Aug.4th, and it appeared on the other two days. Furthermore, a frequency range of 1-10GHz is used, and a scanning length is 8m with a scanning interval of 1cm. Figure.2 shows reconstructed image of HH component, where a dataset acquired on Aug.4th is used, and a frequency range of 4-7GHz is used for an image reconstruction. We can find columns of the rice which is almost parallel to the horizontal axis of azimuth direction.

4. DATA ANALYSIS AND DISCUSSION

Here, we focus on which frequency range and polarimetric component are sensitive to a difference of the rice condition, the emergence of the ear. Thus, the acquired datasets are processed as the followings. Firstly, the frequency range of 1-10GHz which is used for the measurement is equally divided into nine ranges. Then, radar images are constructed with SAR processing for every range. Furthermore, average values of the images are calculated. Same implementation is done in HH, HV and VV components. Calculation result is shown in Figure.3. Here, average values of the image intensities are plotted as a function of frequency ranges, and (a), (b) and (c) are for HH, HV and VV components, respectively. Note that the HH components changes critically due to the ear emergence, although other two components do not give big difference. Especially in the ranges of 5-6GHz and 6-7GHz, there are more than 10dB differences. It is explained by a horizontal component of the ear. If the ear grows, it bows down and gives a reflection of HH component, although a rice plant only has vertical component before the ear emergence.

5. CONCLUSION

In this paper, a GB-SAR measurement in a paddy field and analysis of acquired datasets are shown. The measurements were done before and after the ear emergence of the rice plant. A frequency range of 1-10GHz is used for the measurements, and radar images are reconstructed for nine equally-divided ranges. From the result, we could confirm that the images of HH component give clear differences due to the rice condition. Especially, images of frequency range of 5-6GHz and 6-7GHz shows more than 10dB differences. As a future work, we are planning to a GB-SAR measurement campaign from a rice planting to a rice harvesting in 2009, and apply polarimetric analysis. As for the rice growth, there are many steps, not only the ear emergence, so we hope that some other polarimetric behavior due to the growth would be found. Moreover, comparison of a GB-SAR data and a spaceborne data such as TerraSAR-X and ALOS/PALSAR is considered.

[1] Z.-S. Zhou, W.-M. Boerner, and M. Sato: “Development of a Ground-Based Polarimetric Broadband SAR System for Non-Invasive Ground-truth Validation in Vegetation Monitoring”, IEEE Trans. Geosci. and Remote Sensing, Vol. 41, No. 9, September2004.

[2] http://www.faes.pref.miyagi.jp/engfropage.htm