SEASONAL CHANGE MONITORING OF WETLANDS BY USING AIRBORNE AND SATELLITE POLSAR SENSING

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1. INTRODUCTION

With recent progress of global warming, it has been increasingly important to monitor and observe natural resources. Polarimetric Synthetic Aperture Radar (POLSAR) sensing using fully polarimetric scattering information is one of the most useful radar sensing techniques. It makes detailed and wide area monitoring of natural resources possible under severe conditions where one cannot carry out on-site inspection for grasping the circumstances. As a case study of natural resource observations based on POLSAR sensing, we previously examined seasonal water area change of a wetland, “SAKATA (Niigata City, Japan)”, by using POLSAR data acquired by airborne Pi-SAR system [1]. The scattering power decomposition method [2, 3] was utilized in the literature. According to the power decomposition scheme [3], the total power is decomposed into double-bounce scattering, surface scattering, volume scattering, and helix scattering components. It was found from the result of the image analysis that the double-bounce scattering generated from emerged-plants around water area in the wetland is considered as a useful marker for precisely estimating the true water area of the wetland. Here, the true water area includes not only the body of water but also the water area under emerged and floating-leaf plants in the wetland.

Recently, a satellite POLSAR, “ALOS/PALSAR”, which was launched on Jan. 24, 2006, has provided valuable fully polarimetric data in all kinds of observation areas. The satellite sensor serves wide area observations periodically, whereas the resolution of the sensor is not as high as that of airborne Pi-SAR. So we do not confirm that the useful classification marker, i.e. the double-bounce scattering within the emerged-plants, is still observed from the data sets acquired by the satellite POLSAR.

In this report, in addition to the airborne Pi-SAR data, we carry out further investigation on the true water area of the wetland, “SAKATA”, by using the satellite ALOS/PALSAR data, and check the appearance of the double-bounce scattering marker. The scattering power decomposition method is again utilized here. It is found from the detailed image analysis that the true water area classification marker by the double-bounce scattering contribution is observed from the images of the satellite ALOS/PALSAR data, even though the radar illumination angle is quite different from that of the present Pi-SAR data. Further detailed analyses and considerations will be proposed in the presentation.

2. SCATTERED POWER DECOMPOSITION

Let us simply show the power decomposition procedure for the covariance matrix \((\langle|C|\rangle)^{HV}\) derived by the scattering vectors \(k_{HV} = [S_{HH}, \sqrt{2}S_{HV}, S_{VV}]^T\), where \(T\) denotes transposition. By using a four-component scattering model [3], \((\langle|C|\rangle)^{HV}\) can be expanded into double-bounce scattering, surface scattering, volume scattering and helix scattering as

\[
(\langle|C|\rangle)^{HV} = f_d|C|_{\text{double}}^{hv} + f_s|C|_{\text{surface}}^{hv} + f_v|C|_{\text{vol}}^{hv} + f_c|C|_{\text{helix}}^{hv}.
\] (1)

According to the decomposition algorithm in Ref.[3], the total scattered power can be successfully decomposed into each scattering component, \(P_s\), \(P_d\), \(P_v\), and \(P_c\). For wetland monitoring, the double-bounce scattering \(P_d\) may be generated from right angle dihedral structures composed of vertical stems of emerged-plants and water surface when the water level becomes relatively high (See Fig.1), so it can be utilized as a useful marker for distinguishing the true water area of the wetland [1].

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3. POLSAR IMAGE ANALYSIS

Four scattering component decomposition method is applied to the POLSAR data around "SAKATA" acquired by both airborne Pi-SAR and satellite ALOS/PALSAR systems. Figure 2 shows the power decomposed results for the POLSAR data sets measured in spring season. Figure 2 (a) is the result of the Pi-SAR data, and Fig.2 (b) is the result of the ALOS/PALSAR data. Both images are measured at L-band (1.27GHz). In the figures, the decomposed scattering powers are color-coded as follows. 1) Red is painted for double-bounce scattering $P_d$, 2) Blue color is for surface scattering $P_s$, and 3) Green is for volume scattering $P_v$. The 4th helix scattering component $P_{h}$ becomes minor contribution for the natural distributed target area, so we display the above three scattering components only. In both images, there are several red color spots for $P_d$ not only at the water-emergent boundary but also within the emerged-plants region surrounding the water area, although most of the region shows blue or green. The red spots (double-bounce scattering) may be caused by locally fine dihedral structures constructed between the vertical stems of emerged-plants (reeds) and water surface. It is notable that this true water area classification marker "$P_d$" is observed not only from the Pi-SAR image but also from the ALOS/PALSAR image, regardless of the difference of the image resolution and the dissimilarity of the illumination direction to the boundary.

Taking into account this result, we conclude that the double-bounce scattering within the emerged-plants area is still considered as a useful marker for distinguishing the true water area in the wetland even when the ALOS/PALSAR data is utilized for the image analysis.

4. REFERENCES

