THE EFFECT OF ORIENTATION ANGLE COMPENSATION ON POLARIMETRIC TARGET DECOMPOSITIONS

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1. INTRODUCTION

Polarimetric target decompositions [1-7] were developed to separate polarimetric radar measurements into basic scattering mechanisms for the purpose of geophysical parameter inversion, terrain and target classification, etc. Polarimetric decomposition theorems can be divided into two categories: coherent target decompositions and incoherent target decompositions. Recent studies in the coherent target decompositions, notably by Krogager [4], Cameron [5], and Touzi [6], are based on the scattering matrix data, which is subject to the speckle effect [8]. The incoherent decompositions average the polarimetric data of neighboring pixels, and include additional information of statistical correlations between polarizations. Based on the eigenvector decomposition of a covariance matrix, van Zyl [3] decomposed the data into three basic scattering mechanisms: even bounce, double bounce and diffuse scattering. The other eigenvector based decomposition developed by Cloude and Pottier [1] applies it to the coherency matrix, which was formatted to hold three basic scattering mechanisms. In a different approach, Freeman and Durden [2] developed an incoherent decomposition based on scattering models of surface, double bounce and volume scatterings. This decomposition requires the assumption of reflection symmetry, which assumes the correlations between co-polarization and cross-polarizations are zero. Yamaguchi [7] generalized the Freeman and Durden decomposition by adding a fourth component, helix scattering, to avoid the assumption of reflection symmetry.

2. POLARIZATION ORIENTATION ANGLE SGIFTS

Polarization orientation angle is the angle of rotation about the line of sight. For reflection symmetrical media, such as horizontal surface, the orientation angle is zero. For polarimetric SAR data from rugged terrain areas, the orientation angle will be shifted from zero. Polarization orientation angle shifts are induced by surfaces with azimuthal slope and buildings that are not aligned in the along-track direction [9]. These shifts produce higher cross-polarization (HV) intensity and makes coherency or covariance matrix reflection asymmetrical [8]. Target decomposition based on the uncompensated data may produce scattering characteristics that could be misinterpreted. It has been demonstrated that orientation angle shifts can be compensated by the rotation of the negative of the orientation angle. Based on the NASA/JPL AIRSAR data of Camp Roberts, California, the orientation angle compensated result is shown in Fig. 1 for a profile of 200 pixels. We observe that the orientation angle spans from -25° to 23°. The estimated orientation angles were used to compensate the coherency matrices by applying rotation transformation. Independent elements of the coherency matrix are plotted. The original values are shown in thin lines and the after compensated values are shown in coarse lines The effect of compensation will reduce the $|HV|^2$ term and increase the $|HH-VV|^2$ term, and the $|HH+VV|^2$ term remains unchanged (i.e., rotational invariant). The correlation terms between co-pol and cross-pol are also reduced.

3. THE EFFECT OF ORIENTATION ANGLE SHIFTS ON SCATTERING MODEL BASED TARGET DECOMPOSITION

In this paper, we will demonstrate the effect of orientation angle rotation on incoherent target decompositions of the scattering model based decompositions by Freeman and Durden [2], and by Yamaguchi et al. [7]. We found that, in rugged terrain areas, tilted surfaces that is misinterpreted as volume scattering in the uncompensated data are corrected as surface scattering. Also the city blocks not aligned in the along track direction will less likely classify as volume scattering, because the HV term has been reduced. However, the eigenvector based decomposition of Cloude and Pottier [1] in terms of entropy, anisotropy and alpha angle is not affected by the orientation angle compensation, because they are rotational invariant. The effect on coherent decomposition will also be discussed. Polarimetric data from airborne SAR, such as AIRSAR and E-SAR, and from space borne ALOS/PALSAR are used for evaluation.

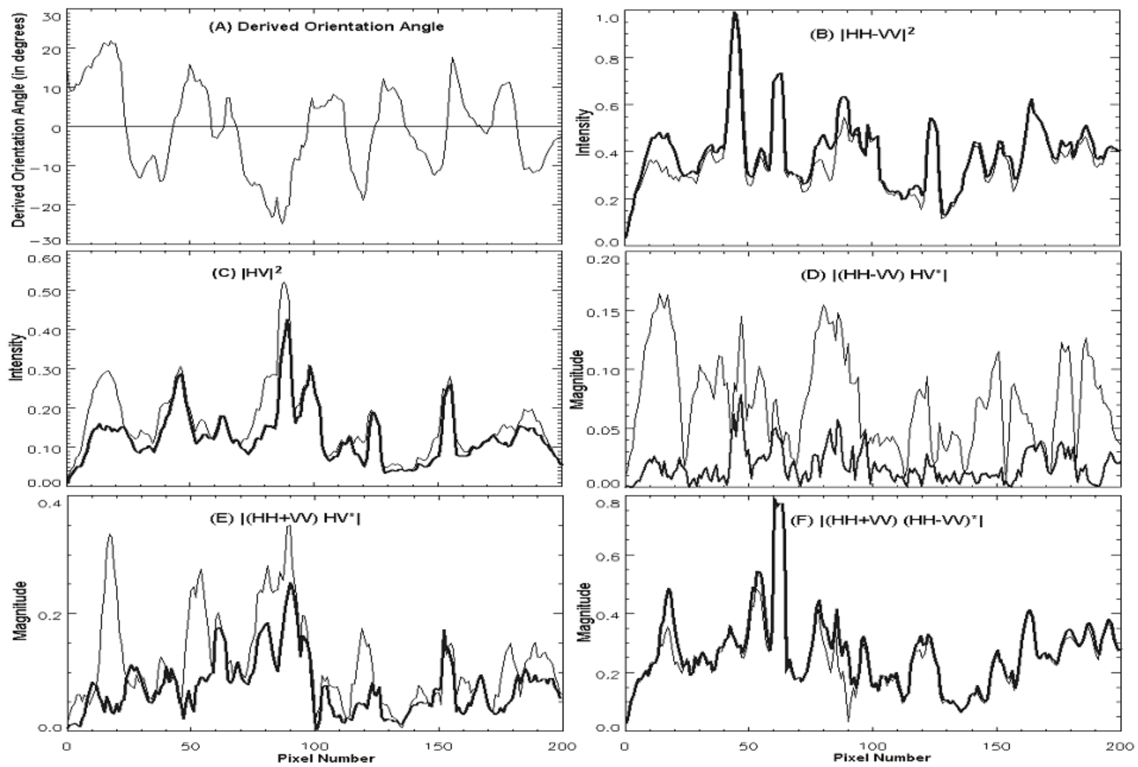

FIG. 1. Data compensation for orientation angle variations. The heavy lines show the magnitudes of the coherency matrix components after compensating for the orientation angle effect.

11. REFERENCES

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