POLARIMETRIC ANALYSIS OF DUAL-POL SAR IMAGERY

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1. INTRODUCTION

Analysis of dual polarimetric SAR imagery has taken on new importance with the recent launches of the ALOS PALSAR, TERRASAR-X and RADARSAT-2 polarimetric SAR systems. While these space borne, polarimetric SARs can provide full polarimetric imagery, a majority of the collected imagery will be restricted to dual polarimetric imaging modes. Here we develop polarimetric analysis methods specific to the dual-pol imaging modes typically available from the new space borne SAR systems, i.e. (HH, VH), (VV, HV) and (VV, HH). Thus an important question is: How best to employ and analyze the dual polarimetric imagery that will be collected by these space borne polarimetric SAR systems?

In this work we emphasize two polarimetric analysis techniques: the eigenvector / eigenvalue decomposition of the dual polarimetric covariance matrices, and the dual polarimetric signature plots.

The eigenvector / eigenvalue analysis is a well known technique borrowed from the polarimetric analysis of fully polarimetric SAR imagery. Applied to quad-pol imagery the Cloude-Pottier polarimetric decomposition has proved very useful. However, when applied to the various dual-pol imaging modes the meaning and interpretation of the eigenvectors characterizing dual-pol scattering mechanisms differs from the quad-pol case. In fact comparisons between the different dual-pol imaging modes are not always straightforward. The reason for the difficulty is that different dual-pol imaging modes collect different aspects of the full polarimetric response. The polarimetric information retrieved from an (HH, VH) dual-pol image is not the same as information from a (VV, HV) image pair. The familiar quad-pol alpha-entropy plot separates different average scattering mechanisms by their averaged alpha angle values and polarimetric randomness by the entropy. While in the dual-pol version of this plot the entropy still shows polarimetric randomness, the meaning of the second variable, the "dual-pol alpha angle", depends upon the dual-pol imaging mode, e.g. (HH, VH) or (VV, HV). Interpretations of these dual-pol plots will be presented for each of the standard dual-pol imaging modes.

The so-called dual polarization signature plot provides a convenient, graphical means to display dual polarimetric information. Whenever a single polarization is transmitted and orthogonal polarizations are coherently received the returned signal may be characterized by the ellipticity and orientation angles of the polarization ellipse. For a given scatterer and transmitted polarization, the dual polarization signature displays the strength of the backscattered return as a function of these orientation and ellipticity angles. The dual-pol signature plot displays the complete polarimetric information available for any dual-pol imaging mode. The dual-pol signature plots provide both a quick and accurate assessment of dual-pol scattering properties.

2. SUMMARY

We employ both quad-pol imagery and simulated polarimetric data as a basis for all comparisons both amongst the dual-pol imaging modes and with the full quad-pol results. In addition to the standard linear polarization dual-pol modes available to PALSAR, TERRASAR and RADARSAT, we also consider hybrid dual-pol modes, e.g. transmitting a circular polarization and coherently receiving H and V linear polarizations. The dual polarimetric analysis methods developed should aid the interpretation and future application of dual polarimetric SAR imagery.