A Study on LOS Rotation Angle Estimation Methods Using Coherent Scatterers

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Abstract

In the last decades several methods were developed for the estimation of Line of Sight (LOS) rotation angles of deterministic and distributed scatterers by exploiting radar polarimetry. Examples are the circular polarization algorithm proposed by Lee, the beta angle of the Cloude–Pottier polarimetric coherence matrix decomposition, the Cameron angle of the scatterer maximal symmetry axis, the minimum cross–polarization algorithm, the orientation of the maximum co–polarization state defined by Kenaugh/Huynen and its estimation through the Graves matrix or the polarization–ratio formalism by Boerner. Some of them are evaluated over extended while some over deterministic (or point–like) scatterers making use of first and/or second order polarimetric statistics, or using directly the information from the scattering matrix.

In [1] the relationship between the different LOS estimates has been addressed on a numerical basis. All individual approaches may be divided into two main classes that are fundamentally different: the ones based on a Consimilarity Transformation (CTBR) and the ones based on a Rotation Transformation (RTBR). In this paper we further investigate the relationship between CTBR and RTBR and present now an analytic formulation. Although in many cases the estimation of LOS rotation angles through CTBR and RTBR is the same, this is not the case for general asymmetric scatterers. Motivated by the divergences of the approaches under different scatterers asymmetric conditions, new parameters are defined from the scattering matrix, which are related to the different kinds of asymmetry encountered (and possible to measure using polarimetry) on deterministic scatterers.

The theoretical analysis is supported by the experimental validation using Coherent Scatterers (CSs) detected in SAR images. Coherent Scatterers are scatterers that have a point–like scattering behaviour and are detected through sublooks spectral correlation [2]. Their deterministic behaviour justifies their application on the present study. For the experimental validation, data acquired by DLRs E–SAR system at L–band over the cities of Dresden and Munich are used. Emphasis is given in the detection and interpretation of symmetric and asymmetric (in terms of LOS rotations) Coherent Scatterers.
