TOWARDS A PHYSICAL QUANTITATIVE ASSESSMENT OF MODEL-BASED POLSAR DECOMPOSITIONS

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As we thoroughly motivated in [1] the performance of model-based decomposition approaches for parameter retrieval is still an open issue in PolSAR field. Very few studies have hitherto performed an in-depth analysis of the incoherent model-based decomposition concept (i.e. Freeman-Durden concept) for quantitative remote sensing applications. Some noteworthy examples are the works by Jagdhüber et al. [2], Huang et al. [3], Di Martino et al. [4], and He et al. [5] focused on soil moisture inversion.

The most common strategy employed to assess the performance of remote sensing techniques is based on the direct comparison of some of the output parameters (i.e. soil moisture, vegetation height, or any other) with a ground-truth data set collected simultaneously. On the other hand, it happens that the retrieved values of some of the parameters can only be interpreted in terms of the expected behaviour according to theoretical foundations. The paradigmatic case is the one related to the vegetation orientation and randomness parameters, widely used for characterising the scattering from vegetated covers. It can be stated that their interpretation is merely supported on qualitative features extracted by visual inspection of the arrangement of particles. However, it seems not to be an obstacle in many publications to accept uncritically this apparent matching to describe the vegetation morphology.

In [1] we emphasized the necessity of analysing the estimation accuracy of the whole set of parameters involved in the physical model. To do so, we took as starting point the progress made by several previous contributions based on the original Freeman-Durden approach. More particularly, we focused on the general model proposed by Chen et al. [6] as we consider it includes all the previous improvements reported in the literature concerning the topic. Nevertheless, the purpose of that work could be also accomplished by using any of the other published models (see [7-10] to name a few). We showed that a reasonably overall accuracy can be achieved by including several improvements throughout the inversion procedure. However, only some particular cases were considered and the whole range of input values and the different combinations among them were not employed for such purpose.

We claim that there still remain some open issues regarding the quantitative assessment of model-based PolSAR decomposition as also Ainsworth et al. recently discussed in [11]. The performance analysis for real data is hampered by the usual unavailability of the corresponding ground-truth data for comparison. In addition, due to modelling issues there appear some parameters whose validation and interpretation are subject to a high ambiguity, as it is the case of vegetation orientation and randomness. The questions that remain to be answered are: What is the actual role of them? Can we assign them a consistent physical interpretation or are they acting just as fitting parameters?

The methodology employed in the present work consists on simulating the coherency matrix according to the general model proposed by Chen et al. [6]. Three main scattering mechanisms are assumed (helix component is neglected here). Our hypothesis assumes that an increase of the entropy would lead to a decrease of the parameter estimation accuracy. This methodology is based on the following steps: 1) Generation of noisy samples by applying Lee's method [12]; 2) Inversion of the whole set of parameters according to the procedure shown in Xie et al. [1] (Matlab code available [13]); and 3) Computation of histograms of output parameters, standard deviation and bias with respect to the input values.

Simulations are carried out for different entropy scenarios. The analysis reveals that even the backscattering powers associated with all three basic scattering mechanisms are estimated with an error higher than 10%

for usual scattering scenarios. Low entropy cases where surface dominates, and a double-bounce mechanism exists as a secondary return, lead to an accurate estimation of the whole set of parameters. However, an increasing orientation angle of the dominant surface scattering induces a high error in several output parameters and also in the recovered backscattering powers. This means that parameter retrieval algorithms, but also classification schemes, based on this decomposition values could be compromised for real applications.

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