MULTI-BASELINE POL-INSAR STATISTICAL TECHNIQUES FOR THE CHARACTERIZATION OF DISTRIBUTED MEDIA

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Polarimetric SAR interferometry (POL-inSAR) is a powerful technique for characterizing natural environments in general and vegetated areas in particular. The combination of interferometry and polarimetry permits to isolate and characterize some scattering mechanisms in the elevation direction and was used for the extraction of some geophysical parameters of forested areas, as in [1] [2]. Over complex vegetation environments, whose scattering features may not verify some of the hypotheses done in the studies mentioned above, the extraction of the vertical structure of the observed medium requires more than two polarimetric SAR images. Multi-baseline POL-inSAR (MB-POL-inSAR) provides additional degrees of freedom that can be put to good use for retrieving additional structural parameters [3] [4], enhancing the robustness the estimation process and may lead in a general way to a substantial gain of vertical resolution.
Due to the high-dimensionality of MB-POL-inSAR information and to the stochastic aspect of the SAR response of natural environments, the estimation of MB-POL-inSAR quantities is a critical processing step and greatly influences the quality of retrieved physical quantities [3]. Moreover, the partial correlation of the different SAR images forming the multi-baseline data set implies a non-negligible amount of redundancy with can be efficiently used to increase the analysis robustness and the estimation accuracy [4].

This paper proposes some techniques to efficiently estimate the MB-POL-inSAR information, that are adapted to the estimation of geophysical characterization of natural environments and are based on the analysis of the structure of MB-POL-inSAR multi-dimensional representations.

The first part of the paper concerns the analysis of the MB-POL-inSAR coherency matrix and its statistical properties in particular cases, commonly encountered when observing natural media. Indeed, POL-inSAR characteristics of natural media generally satisfy some simple properties:

- The co- and cross-polarization correlation coefficients of the expectation of the coherency matrix can be null in many cases (reflection symmetry)
- The polarimeric response of a natural medium generally follow the same distribution over all separate acquisitions of an MB-POL-inSAR data set (polarimetric stationary behavior)
- These properties are generally verified by the different POL-inSAR cross-correlation matrices as well (POL-inSAR symmetry and stationary behavior)

In order to test these configurations, statistical tests based on Maximum Likelihood ratios and initially proposed in [5] are generalized to the MB-POL-inSAR case. This statistical analysis shows that in cases for which one of the simplifying hypotheses is verified, classical general expressions used to estimate POL-inSAR coherence are not optimal and should be replaced by ones that are adapted to the corresponding specific configuration.

The second part of this study concerns the estimation of MB-POL-inSAR quantities when combination of some hypotheses mentioned in the first part are verified. Rigorous expressions or derivation techniques of optimal scattering mechanisms are given that complete a previous study [6] and are shown to provide significant insight on the intrinsic structure of the MB-POL-inSAR matrix. The particular case of the line model, proposed by Papathanassiou and Cloude in [2], is investigated and it is

shown that its estimation using several baselines provides more stable parameters as well as increased possibilities in terms of physical characterization.

The last part of the paper concerns the joint use of the proposed techniques together with the MB-POL-inSAR parameter retrieval scheme proposed in [3] for vegetated areas. The improvement of the inversion approaches are quantified on both simulated features and measured data sets acquired at L band by the DLRs ESAR sensor in repeat pass mode with different temporal and spatial baselines

1. REFERENCES

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