Forest/Non-forest Delineation with Space Borne L-Band PolSAR: A Model Based Scattering Mechanism Decomposition Approach

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A reliable monitoring of forest covered areas is of a high importance in various operational and environmental applications, including commercial forest ones. Satellite SAR sensors can reliably provide multitemporal and multipolarization data for effective utilization in forest cover monitoring from a local to global continental extent. In this study fully polarimetric SAR (PolSAR) data acquired by the ALOS PALSAR sensor is used for establishing and investigation of relationships between the backscattered signal and underlying land cover data with the objective of the most accurate forest-nonforest separation.

One of the popular and physically reliable ways of the collected PolSAR data interpretation is decomposing its second order statistics into a sum of simple scattering mechanisms' contributions. Two main approaches include eigenvalue based decomposition of polarimetric coherency matrix [1], and model based decomposition of polarimetric covariance matrix [2]. Advantage of the last mentioned and other similar methods is in a possibility of direct interpretation of the PolSAR data in terms of different scattering components: surface, volume, double scattering, etc. These components can be used further as polarimetric features for characterization of different land cover types and enable proper distinguishing between them.

A simple rule based approach is formulated for detecting forest areas on the basis of polarimetric signatures of the boreal forest at L-band, with ground reference data used for calibration and evaluation of the results. One of the most critical issues for solving the forest/non-forest separation problem is an adequate modeling of the volume scattering component. The widely used volume scattering model introduced in [2] represents randomly oriented volume of thin dipoles. It can be effectively used for description of coniferous forests, but may be not adequate for other canopy types. Several simple models were recently proposed with respect to a predefined particle shape and preferable orientation of the particles in some chosen direction, e.g. in [3]. These models, as well as traditional one, are compared to see which performs better in the boreal forest area using the developed rule-based framework.

The proposed approach was tested on several sites in the central and northern Finland. Observed increase in the double bounce scattering reveals potential for distinguishing between sparse and dense forest areas, while the particle shape parameter was found to be dependent on the forest type. It is in good agreement with theoretical results. The binary forest/non-forest classification showed generally high performance with classification accuracy up to 85% from a single SAR acquisition. Results are expected to be even better once multitemporal data is used.

References

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