POLINSAR 2019
28 January - 01 February 2019 | ESA- ESRIN | Frascati (Rome), Italy

Incoherent Polarimetric target scattering decomposition: An overview and their implementation on TerraLib system

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INTRODUCTION

Target Decomposition consists of the study of target characterization by identifying the different scattering mechanisms based on the scattering matrix decomposition. In this work, we address the so-called incoherent target decomposition, which could be spitted into two main groups: the first one are the decomposition based on models, such as the Freeman-Durden decomposition (FREEMAN; DURDEN, 1998); the second group is the one based on eigenvalues analysis, such as, the Cloude-Pottier decomposition (CLOUDE; POTTIER, 1996). In this work, we show the results of Freeman-Durden and Cloude-Pottier decomposition implementation in the TerraRadar framework.

TERRALIB AND TERRARADAR

The TerraLib is a GIS (Geographic Information Systems) component library developed by INPE (National Institute for Space Research) and contributors. This library consists of a set of classes and functions written in the C ++ language (TERRALIB, 2018), which has, among of others, the purpose to provide decoders for different raster data format. The TerraRadar is the framework used to develop the algorithms presented here. This framework uses the TerraLib Library for image data handling. Figure 1 shows the TerraRadar modules and its relationship with TerraLib.

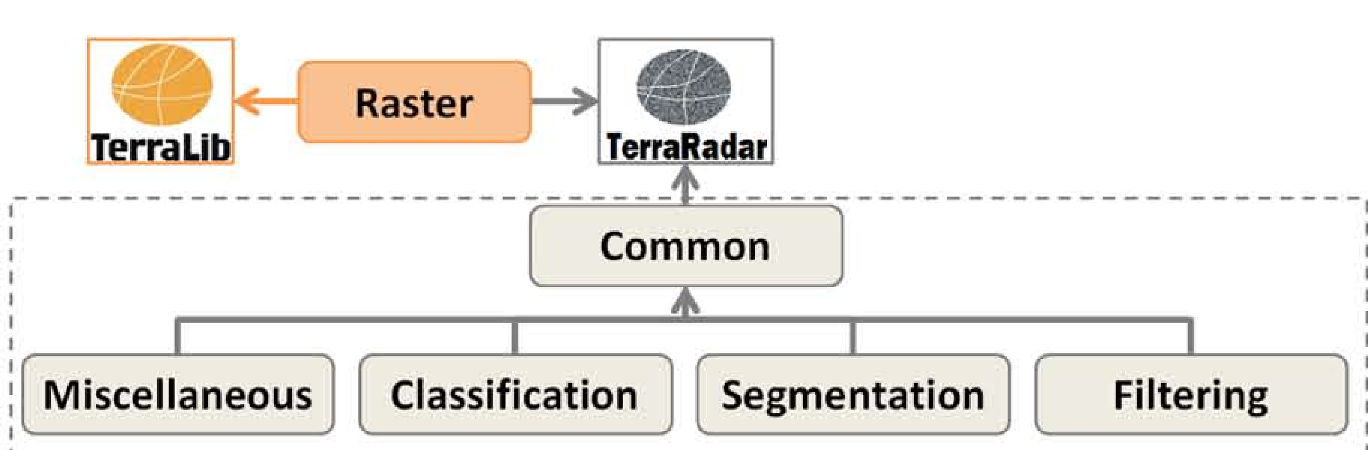

Figure 1. TerraRadar framework modules.

CLOUDE-POTTIER DECOMPOSITION

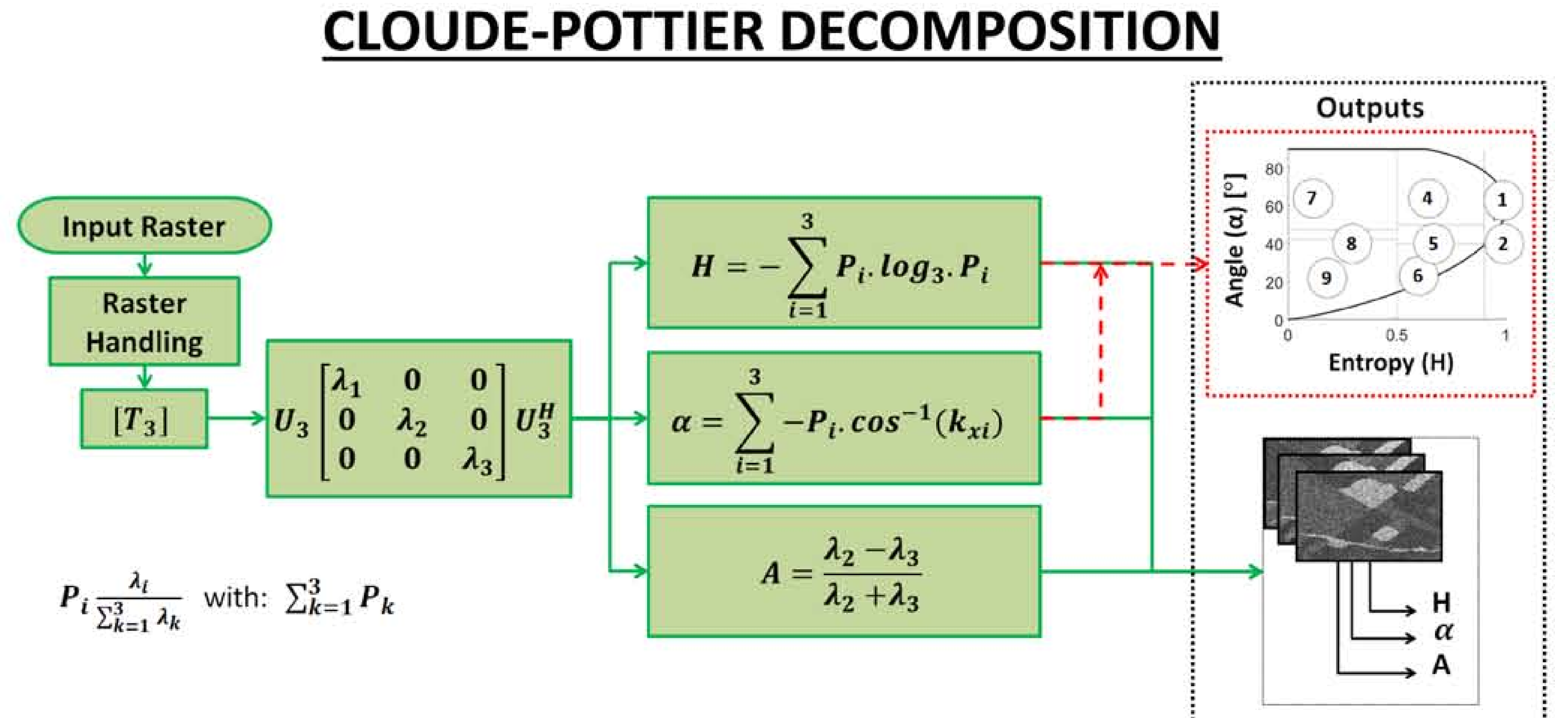

Figure 2. Cloude-Pottier decomposition algorithm flowchart. The input of this algorithm must be a raster image with at least three polarimetric bands (S_{hh}, S_{hv} and S_{vv}). From those images the Coherence matrix [T] is obtained. From [T], the entropy (H), alpha angle (α) and Anisotropy (A) are computed. The algorithm output are: the H- α plan and the images representing the entropy, alpha angle and anisotropy.

FREEMAN-DURDEN DECOMPOSITION

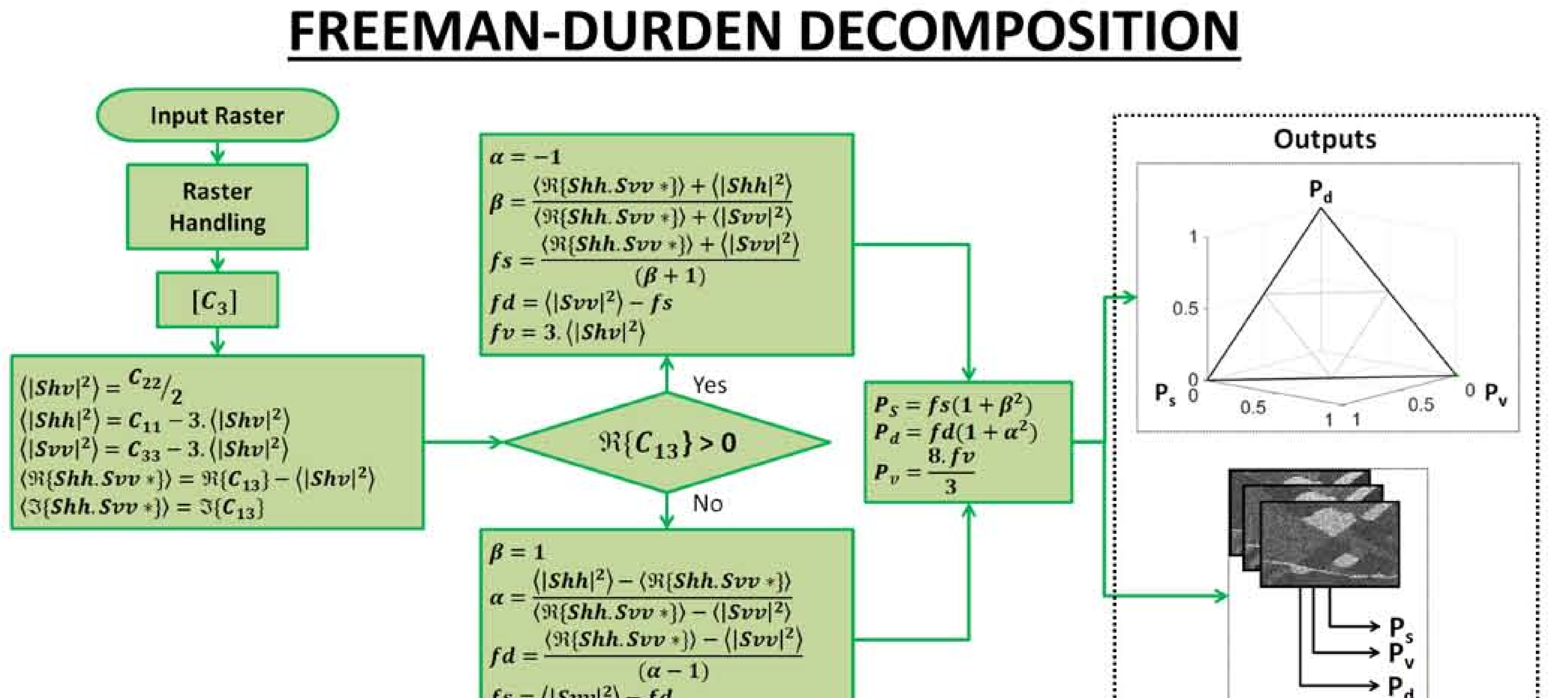

Figure 3. Freeman-Durden decomposition algorithm flowchart. The input of this algorithm must be a raster image with at least three polarimetric bands (S_{hh}, S_{hv} and S_{vv}). From those images the Covariance matrix [C] is obtained. From [C], the P_s, P_d and P_v are computed. The P_s component represents scattering models of surface, the P_v component represents volume scatterings and the P_d component represents double-bounce scatterings. The algorithm output are: the P_s-P_d-P_v space and the images representing the three components.

RESULTS

The tested images are from a cut over part of the Tapajós National Forest, located in Belterra, State of Pará, Brazil. This area is considered an important conservation unit in the Brazilian Amazon Forest. The PolSAR images were obtained by ALOS PALSAR 1. The images polarization are HH (S_{hh}), HV (S_{hv}), and VV (S_{vv}) with a estimated number of looks equal to 5. In Figure 4 is shown the analyzed area and the PolSAR colored composition. The Cloude-Pottier and Freeman-Durden decomposition results are shown in Figure 5.

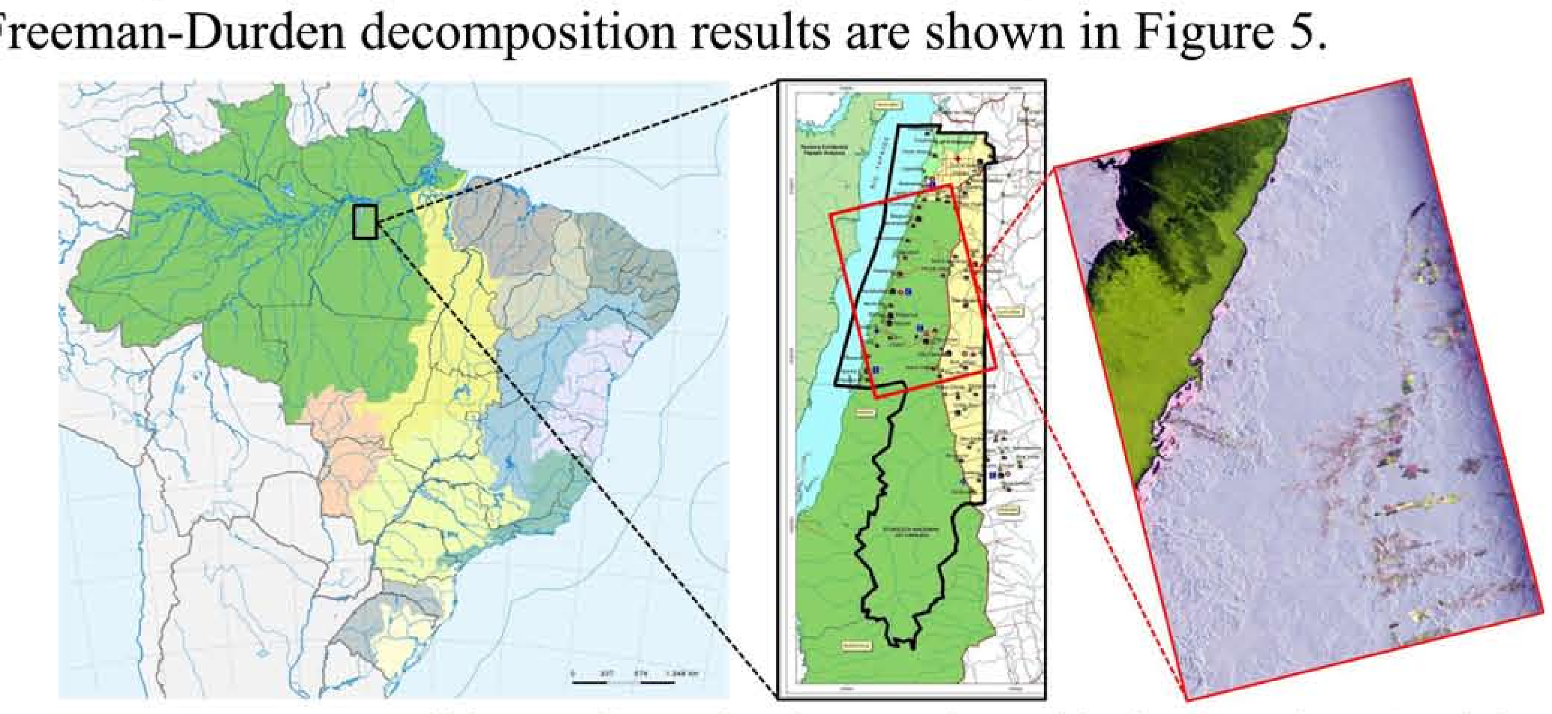

Figure 4. Cut over part of the Tapajós National Forest, located in the state of Pará and the PolSAR colored composition (R = S_{hh}, G = S_{hv}, B = S_{vv})

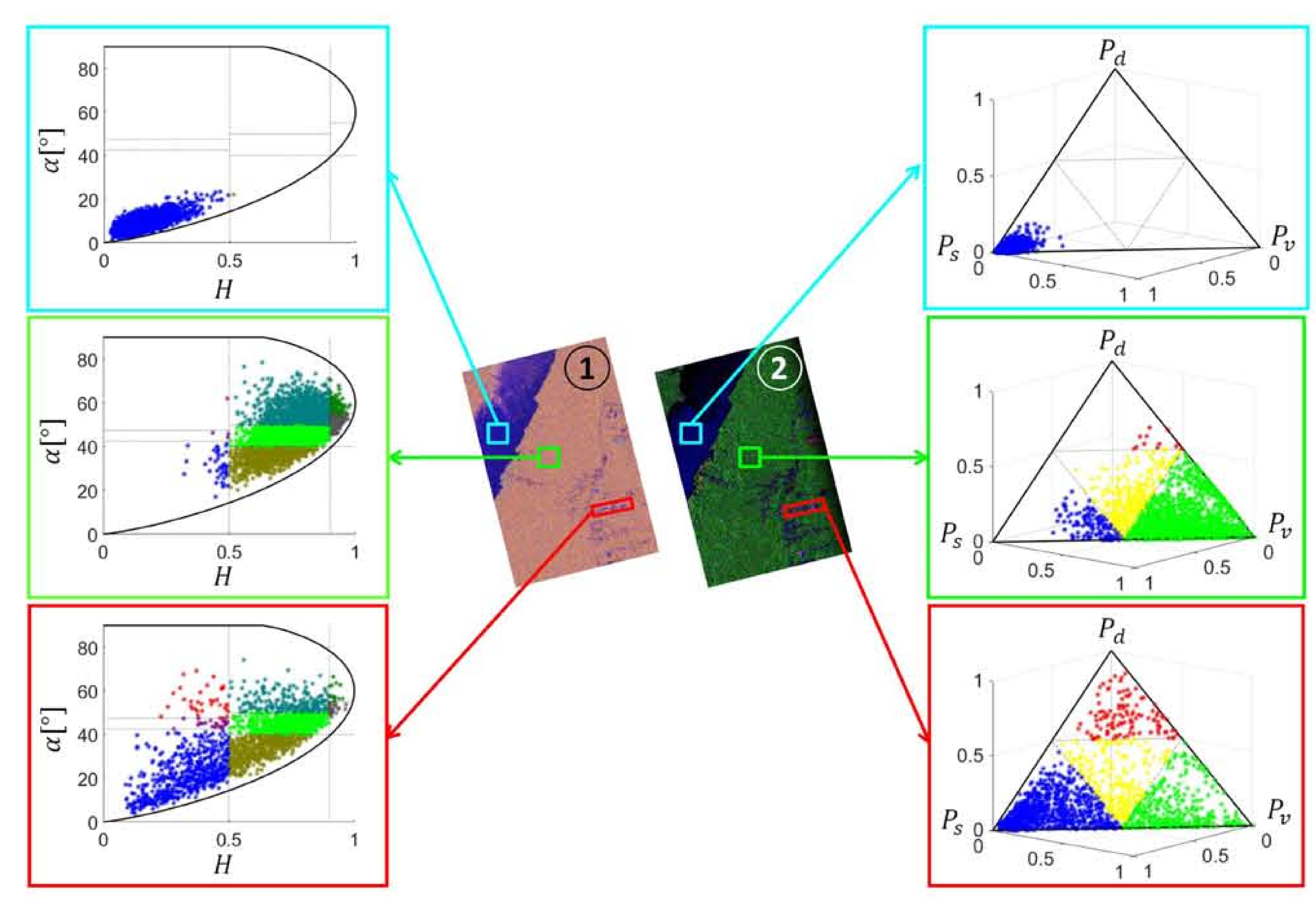

Figure 5. In picture (1) is shown the Cloude-Pottier decomposition result with R = H, G = α and B = A. In picture (2) is shown the Freeman-Durden decomposition result with R = P_s, G = P_v, and B = P_d. The graphs at left represent the H-α Plan and the graphs at right represents the P_s-P_v-P_d space. In the decomposition pictures, the cyan square represents the river samples, while the green ones represents the forest samples and finally the red rectangle represents deforestation areas.

This study confirms the incoherent decompositions potential in analyses of forest areas and for detection of forest cover degradation. The results of both decompositions are aligned. For example, in Figure 5, the samples representing the river (in cyan) have low entropy and low alpha angle, indicating a smooth scattering, while in the P_s-P_d-P_v space the samples are located mostly close to P_s which represents surface scattering. In deforestation areas (in red) the samples are spread in entropy axis and have a low to medium alpha angle indicating a confused information, since there is primary and secondary forest near, soybean cultivation, and exposed soil; similarly the P_s-P_d-P_v space indicates that the samples have surface scatterings (exposed soil), volume scatterings (forest, for example) and double-bounce scatterings (cutted trees stems). Therefore, the obtained results are in agreement with the expected answer.

REFERENCES

CLOUDE, S. R.; POTTIER, E. A review of target decomposition theorems in radar polarimetry. *IEEE Transactions on Geoscience and Remote Sensing*, IEEE, v. 34, n. 2, p. 498–518, 1996.
FREEMAN, A.; DURDEN, S. L. A three-component scattering model for polarimetric sar data. *IEEE Transactions on Geoscience and Remote Sensing*, IEEE, v. 36, n. 3, p. 963–973, 1998.
TERRALIB, 2018. TerraLib and TerraView Wiki Page. Available at: http://www.dpi.inpe.br/terralib5/wiki. Accessed 8 January 2019.

ACKNOWLEDGMENTS

This research was supported by the National Institute for Space Research – INPE.