Comparison of different compact polarimetry modes in respect to the full polarization for the identification and characterization of the land use classes

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Radars operating in compact polarization (CP) provide an alternative to fully polarimetric (FP) radars that is becoming more popular and accessible because of, notably, their simpler architecture and a wider swath which is typically double. The RISAT-1 (2012) and ALOS-2 (2014) satellites have a CP acquisition mode. The SAOCOM1 & 2 (2015/16) satellites and the Canadian Radarsat Constellation Mission (RCM), to be launched in 2018, will also be equipped with a CP acquisition mode. Research into compact polarimetry are varied and concern 1) both the evaluation and comparison of different CP modes ($\pi$/4, CTLR, DCP); 2) the comparison of CP and FP modes with respect to the loss of information caused by the transmission of a single polarization in CP mode; 3) the synthesis of pseudo covariance matrices and; 4) the development of specific tools for the processing and analysis of compact data [1], [2], [3].

These four aspects will be explored using the algorithms available in the PCI Geomatics’ Geomatica2017 suite. The $\pi$/4, DCP and CTLR CP modes are first synthesized from two Radarsat-2 fine quad polarization time series; one acquired in 2010 over the Ottawa Region (FQ28) and the other in 2009 over the Lac Saint-Pierre Area (FQ15). A pseudo-covariance matrix is reconstructed for each CP mode using a generic extension of the iterative approach described in [1]. Thereafter, the Touzi [4] and the Cloude & Pottier [5] incoherent decompositions are generated for each reconstructed pseudo coherence matrix and a detailed correlation analysis of the observed disparities between the polarimetric parameters derived from the CP modes, in comparison with the FP mode, is conducted. A database of land uses, created from a cross between the classification of a Landsat TM image and the CanVec vector data at the scale of 1: 50,000, is used for validation purposes. Results shows that the quality of reconstructed pseudo-quad data depend strongly on the anisotropy ($\alpha$). When the Anisotropy is high (significant contribution of a second scattering mechanism), reconstructed pseudo-quad data does not correlate well with FP data and significant under or over estimation of the scattering type ($\alpha_{11}$, $\alpha_{22}$), the scattering coefficients ($\sigma_{hv}^0$, $\sigma_{vv}^0$, $\sigma_{hh}^0$) or the eigenvalues ($\lambda_1$, $\lambda_2$, $\lambda_3$) are observed. This happens mostly for wetlands and crops like maize and soy in late spring or early fall. Those results were compared with those obtained from algorithms designed for the processing of CP data, notably the polarimetric discriminators found in [1], [2] and [3]. Results show that it’s better to use the CP orientation and ellipticity angles from those algorithms than the reconstructed pseudo-quad orientation ($\beta$, $\psi$) and ellipticity ($\tau$) angles from [4] and [5].