Assessment of compact polarimetry in case of different dataset and study site for land use monitoring over tropical environment

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In the context of the global warming it is necessary to better understand the biosphere dynamics and its evolution. Consequently the tropical forests are particularly watched on due to their interaction with the global climate. In this context, remote sensing is a valuable tool allowing repetitive observations over wide forested areas. In particular, SAR data are particularly well suited over tropical regions characterized by quasi-permanent cloud cover limiting optical observations. Several spaceborne SAR sensors have been launched since 2007, operating at L band (ALOS-PALSAR), C band (RADARSAT-2) and X band (TERRASAR-X). The diversity of the frequency bands as well as the polarization configurations allows for a better discrimination of the different land use / land cover.

Fully SAR polarimetric data allow for the characterization of the scattering mechanisms occurring within a resolution cell. Consequently, they are sensitive to the geometrical structure of the scatterers distiburion as well as their orientation. Past studies have shown that radar polarimetry is especially well suited for the discrimination between different tropical forest types. However, such sensors require the alternating transmission of two orthogonal polarizations, leading to halve the swath by comparison to Dual Polarimetric mode. Consequently, the time revisit is also twice longer which is an important limit for a land surfaces monitoring. By contrast, the Dual polarimetric mode like hh/hv available with PALSAR, which may loose an significant part of the fully polarimetric information.

On the other hand, a Compact Polarimetric mode has been presented [Souyris et al., 2005] consisting in the transmition one circular polarization (left or right) and the reception along two orthogonal polarizations. The fully polarimetric coherency matrix may then reconstructed under assumptions of reflexion symmetries and an extrapolation of the degree of coherence between hh and vv polarizations. This polarimetric configuration appears to give a good compromise between system constraints (among which the swath width) and the preservation of polarimetric information.

The goal of this work is to assess the potential of Compact Polarimetry for different dataset and study case. Indeed, the main constraint to reconstruct the pseudo fully polarimetric information is the symmetry reflexion which is theoretically verify under natural media on a horizontal plane. However, in some case, like an area with strong azimuth slope or heterogeneous area, this symmetry could not be verified. Thereby, the increasing of the resolution cell or study case with heterogeneous area could strongly influence the suitability of the pseudo fully polarimetric reconstruction.

Study sites and datasets:

(1) AIRSAR data: The Tubuai Island at the middle of the South Pacific Ocean is quickly evolving in the tourism industry, and from the economic and geostrategic points of view. They are thus subject to a strong environmental planning leading to landscape changes as well as to the introduction of invasive species. Thus this study site that was the focus of a previous study [Lardeux et al., 2009], which is particularly relevant for its forest and land use diversity, was covered by an AIRSAR mission August 2000 that allow to compare fully polarimetric mode of L and P bands to simulated Compact polarimetric mode over a pixel of 5m.

(2) PALSAR data (Full Pol. Mode)

1. The French Guyana is located in the north of South America at the edge of Atlantic Ocean. In reason to this location, the French Guyana is mainly covered by tropical forest (primary forest, mangrove...). The study site, located near Cayenne, is also covered by swampy vegetation,

Savannah and some urban area. The cartography of this study site is helped by a SCAN25 map, aerial photography of IGN, and some airborne photography

2. The São Nicolau Fazenda, in Mato Grosso state - Brazil, which was clear cut in the early nineties and reforested between 1999 and 2003 with native and foreign species. Since1999, the Office National of Forestry International (ONFI) is conducting annually in the reforestation area a forest inventory (tree growth, mortality, biomass estimation, carbon stock assessment...) which constitutes an important ground truth for forest stratification according to carbon and biomass growth
3. The southern Cardamoms ecosystem, in Koh Kong Province - Cambodia, a tropical evergreen forest with smaller pockets of semi-evergreen and deciduous forests under high deforestation pressure. ONFI is collecting forest inventory data in a 200.000 ha in the framework of a climate mitigation project
4. A large private forest concession area in Cameroon, where forest inventory (used to build the forest management plan) will be available for forest stratification

In order to compare the Fully Pol. mode and simulated Compact Pol. mode, we apply the Support Vector Machines (SVM) algorithm, [Burges, 1998], to classify our data. Indeed, this method is especially well suited to handle linearly non separable case by using the kernel method. It has been mostly applied to hyperspectral remote sensed data, but past studies have also shown its suitability for SAR data. As it is especially well suited to high dimension vectors, significant results has been obtained for full polarimetric SAR data, [Lardeux et al., 2009].

From each of the evaluated modes we extract different polarimetric indicators directly relative to theses latter, like intensities, or the degree of coherence between the measured polarizations. In addition, from the fully (or pseudo fully) polarimetric information, we extract other polarimetric indicators like the Pauli decomposition or the H/A/α parameters.

Preliminary results show a strong difference between the compact polarimetric mode performance over the Tubuai (AIRSAR data) and French Guyana (PALSAR data) study site. Indeed, in the case of L band of AIRSAR data over the Tubuai island, the compact Pol. mode have a mean accuracy of 78% versus 90% for the fully Pol. mode, and respectively 93% and 94% in the case of PALSAR data in French Guyana. It could be explain by a strong homogeneity of the study classes observed in the PALSAR dataset contrary to the AIRSAR dataset.

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