EXPLOITATION OF ALOS-PALSAR SAR FULL-POLARIMETRY DATA TO THE MAPPING OF AN AFRICAN REGION

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ABSTRACT

Due to their large scale of observation and their relatively high revisiting frequency, spaceborne SAR systems offer interesting possibilities for the systematic monitoring of land cover. Several techniques have been developed to analyze land cover areas from single-polarization spaceborne SAR data, based on the statistical properties of the reflectivity of such complex media and its spatial variations (texture). The reduced resolution of the data, compared to the airborne SAR case, is a particularly limiting factor. Polarization diversity offers an interesting and powerful alternative mean to characterize land cover areas. In this paper, we propose to use polarimetric SAR acquired by the ALOS sensor at L band, to monitor land cover of an African region.

The first part of this paper is focused on the estimation of soil moisture and Faraday rotation from bare surfaces. In a space environment, one of the most prominent effects of the ionospheric propagation is Faraday rotation. At low frequencies, the ionosphere interaction induces a significant rotation of the wave polarization plane. The ionosphere, which is the highest layer of the atmosphere, is composed of a large quantity of ionized particles. This ionized material becomes anisotropic in presence of the Earth electromagnetic field. As a result, the waves that propagate through the ionosphere undergo a rotation of their polarization vector called Faraday rotation, which is dependent on the total electron content (TEC). As a first estimate for the Faraday rotation angle, TEC maps which are readily available could be used and the rotation corrected for.

However, when such information is not available, it has been shown that the use of fully polarimetric information is a good compromise in the estimation of the Farady rotation. Recently Pascale Dubois et al. have introduced a new parameter: the conformity parameter which can be used for the discrimination of the different canonical scattering types (surface, double bounce, volume) that occur on natural surfaces. This parameter allows the selection of bare surfaces that are invariant with Faraday rotation. Once the Faraday rotation is estimated over such surface, it is thus possible to apply a correction over the whole scene. Such procedure shows a great improvement in the estimation of the soil moisture.

The second part of this paper concerns isolated build-up environments (houses, buildings, farms, villages …) analysis and characterization. The proposed technique uses two complementary approaches to discriminate man-made structures using detectors adapted to the complex polarimetric features of this medium and to isolate specific coherent responses from a Time-Frequency (TF) analysis of the coherent SAR signal.

Polarimetric analysis techniques, based on decomposition onto an orthogonal basis, on a parametric modeling of the response of environments or on specific indicators, have already been applied to the case or urban monitoring. These approaches are used in this section to determine the general intrinsic structure and properties of POLSAR second order representations. This information is then used to build statistical detectors which discriminate specific polarimetric behaviors applied here to separate built-up environments from natural areas. The design of the proposed detectors is driven by physical considerations and, specific precautions are taken in order to ensure a sufficient robustness of the detection process with respect to particular configurations linked to the level of reflectivity of to the rank of the POLSAR coherency matrix.

Conventional scattering analysis and geophysical parameter retrieval techniques from strip-map SAR data generally assume that scenes are observed in the direction perpendicular to the flight track and at a fixed frequency, equal to the emitted signal carrier frequency. These assumptions may lead to erroneous interpretations over complex targets and particularly build-up environments, characterized by anisotropic geometrical structures, showing varying electromagnetic behavior as they are illuminated from different positions and at different frequency components during the SAR integration. In this paper, a T-F analysis of coherent PolSAR data is lead in both azimuth and range directions in order to characterize the spectral content of responses of built-up areas. Given the reduced transmitted bandwidth and processed azimuth angular for spaceborne SAR systems, the analysis differs from the classical airborne ones. It is nevertheless shown that the concept of

polarimetric T-F coherence remains valid and can be efficiently used to detect man-made structures having a coherent behavior. Moreover, the classification of T-F scattering behaviors, as well as the determination of polarimetric coherent scattering mechanisms, permit to obtain an enhanced description of the different parts of a complex build-up area.

These different and specific full polarimetric functionalities are part of PolSARpro v4.0 that is a polarimetric SAR data processing and educational tool developed under contract to the European Space Agency by a consortium led by SAPHIR team from IETR at the University of Rennes 1, The Microwaves and Radar Institute (HR) of DLR and AEL Consultants, together with Dr Mark L. Williams. The PolSARpro v4.0 is available to download free of charge (source code, elements software packages, tutorial, lecture notes …) from the ESA Web Portal (Earthnet) at: http://earth.esa.int/polsarpro.

A global overview of all the main functionalities presented in the former sections, will be presented during the symposium and illustrated using new and recent full polarimetric ALOS-PALSAR data sets, processed using the ESA PolSARpro v4.0 toolbox.