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Added value products for imaging remote sensing by processing actual GNSS reflectometry delay doppler maps

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Global Navigation Satellite System Reflectometry (GNSS-R) is an innovative and promising tool for remote sensing. It is based on the exploitation of GNSS signals reflected off Earth's surface as signals of opportunity to infer geophysical information of the reflecting surface. The main advantages of GNSS-R with respect dedicated sensors are: the unprecedented spatial-temporal coverage due to the availability of a great amount of transmitting satellite, e.g. GPS, Galileo, Glonass, etc..., long term GNSS mission life and cost effectiveness. In fact only a simple receiver is needed. In the last years several works demonstrated the meaningful of this technique in several Earth Observation applications. All these applications presented results obtained by using a receiver mounted on an aircraft or on a fixed platform. Moreover, space borne missions have been launched or are planned: UK-DMC, TechDemoSat-1 (TDS-1), NASA CYGNSS, Geros ISS. Practically, GNSS-R can be seen as a bistatic radar system where the GNSS satellites continuously transmit the L-band all-weather night-and-day signals that are reflected off a surface, called Glistening Zone (GZ), and a receiver measures the scattered microwave signals in terms of Delay-Doppler maps (DDMs) or delay waveforms. These two products have been widely studied in the literature to extract compact parameters for different remote sensing applications. However, products measured in the Delay Doppler (DD) domain are not able to provide any spatial information of the scattering scene. This could represent a drawback for applications related to imaging remote sensing, e.g. target detection, sea/land and sea/ice transition, oil spill detection, etc.... To overcome these limitations some deconvolution techniques have been proposed in the state of the art aiming at the reconstruction of a radar image of the observed scene by processing the measured DDMs. These techniques have been tested on DDMs related to simulated marine scenario including areas with different wind speed, oil spill, non-homogeneous area and cyclone.
In this work a deconvolution technique based on the 2-D Truncated Singular Value Decomposition (TSVD) approach is used to process, for the first time, a real DDM measured by the TDS-1 mission to generate a radar image of the observed scene. The considered DDMs are related to marine scenario including non-homogenous area, i.e. sea/land and sea/ice transition. These non-homogeneous area provide a strong scattering contribution in the DD domain but it is not possible to extract any other information by analyzing the DDM. In the other hand, after the 2-D TSVD technique application a radar image of the observed scenario is provided where the transition between sea and non-homogeneous elements is reconstructed and well located in the spatial domain.
Finally, in this work we demonstrate the soundness of the proposed approach able to provide an added value product for imaging remote sensing to improve/complement dedicated sensors.