FOREST PARAMETERS INVERSION USING POLARIMETRIC AND INTERFEROMETRIC SAR DATA

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Monitoring forest evolution is crucial for understanding the changes of the terrestrial environment and for planning a correct management of natural resources. The estimation of forest parameters from SAR data has been largely addressed in the open literature. Among the different parameters, forest height and trees density play a key role since the biomass distribution is directly related to them. The estimation of forest height and trees density, however, depends on several forest parameters and scene characteristics, such as terrain slope, soil moisture content and roughness. In order to take into account as much as possible forest parameters for the inversion, more observed information about the target are needed. Multi-frequency or multi-polarization SAR sensors and interferometric acquisitions extend the information space of the target. In this contribution, we consider the potential of polarimetric SAR interferometry [1] to invert a set of forest parameters.

Polarimetric SAR interferometry (POLINSAR) uses the interferometric degree of coherence estimated at different polarizations. Different polarizations make possible to discriminate among the scattering mechanisms inside the resolution cell and interferometric processing associate to them a scattering phase height. The combination of the two information allows to retrieve information along the vertical structure of forests and in general the retrieval of bio- and geo-physical parameter from vegetated areas. Several airborne sensors, such as the DLR E-SAR, and recent spaceborne missions, such as ALOS-PALSAR, have been dedicated to the demonstration of POLINSAR technique at L-band over forested areas. In previous works, this demonstration used the prediction of the POLINSAR degree of coherence obtained by a two-layer model that combines the ground scattering contribution with random canopy contribution [1]. This Random Volume over Ground (RVOG) model is based on four input parameters: tree height, mean canopy extinction, ground-to-volume amplitude ratio and ground topography. The inversion procedure [2] from full polarimetric data uses both the amplitude and the phase of the interferometric coherence and gives the estimation of the forest height.

In our work, we adopt an alternative model based on pure electromagnetic scattering theory [3]. Our first objective is to study, using that model, how the bio-physical parameters impact on the POLINSAR degree of coherence measured by the viewing geometry and sensor characteristics of ALOS-PALSAR. We take into account the Faraday rotation and discuss the effect of the temporal decorrelation. This study is not possible using the RVOG model since these parameters are not directly inputs to the model. The second objective is to test a new inversion procedure that uses the information from the model analysis to retrieve some forest characteristics, including the mean trees height [4].

Despite the well known limitations due to the temporal effects, which are more evident for vegetated area, we consider the complete end-to-end POLINSAR processing chain using the ESA ALOS-PALSAR Prototype Processor for the basic SAR processing. Higher-level processing steps are performed using the ESA Toolbox PolSARPro and an improved coherence optimisation algorithm for the best polarisation selection. The difference between the scattering phase center of the ground and of the top of the canopy is optimized through the maximization of the difference between the coherence magnitudes at different polarisations. The results are shown for each step of the processing chain. We start from a pair of PALSAR L1.0 products and focus them by using the ESA SAR Processor; then the calibration of the SLC products according the Jaxa distortion matrices is applied and the Faraday rotation, estimated from TEC data or from the SLC products, is compensated. The co-registration of the INSAR image pair is based on the amplitude correlation and the range spectral filtering. We remove the phase contribution of the flat Earth and optionally reduce the speckle using a refined Lee filter that generates the POLINSAR coherency matrix. The next step is the estimation of the complex degree of coherence and the flattened interferogram, and the selection of the ground and canopy scattering centers through the phase optimisation algorithm. This estimation is corrected using the terrain slope information from an external digital elevation model (DEM). Finally, we test the alternative height inversion approach by comparing the optimised interferograms with the model output and compare it with the classical approach of the RVoG inversion. Interferometric airborne data acquired by E-SAR sensor are also shown as example of lower temporal decorrelation.

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