Understanding Forest Change from P-band Polarimetric and Interferometric SAR Data

Noelia Romero-Puig, Matteo Pardini, Konstantinos P. Papathanassiou

German Aerospace Center (DLR)
Microwaves and Radar Institute (DLR-HR), 82234 Wessling, Germany

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ABSTRACT (Abstract + references maximum 1000 words)

Understanding the changes taking place in the forest structure is key for the correct assessment of forest biomass and productivity. By exploiting polarimetric SAR acquisitions [1], different techniques have been proposed in the past to address changes [2, 3]. These techniques, however, are limited to the detection of changes in terms of radiometric information, i.e. amount of change. In [4], a polarimetric change analysis methodology which takes a step further into the interpretation of the changes between different SAR acquisitions is introduced. This methodology provides a representation of the changes based on the type of change (type of scattering mechanisms) weighted by the amount of change (increasing or decreasing radiometric intensity).

From the radar point of view, forest are complex scenarios. As a result, the polarimetric change analysis [4] over forest scenes at P-band applies on a relatively high entropy scenario. This means that only with polarimetric acquisitions, many ambiguities and uncertainties arise from the superposition of dielectric, phenological and/or structural changes. A way to provide sensitivity to the vertical structure of the forest, and thus break down (some) of these ambiguities, is to incorporate interferometry. By exploiting both polarimetric and interferometric SAR (Pol-InSAR) acquisitions, the radar return from the forest canopy can be decomposed into ground and volume scattering components [5]. This allows to increase the observation space by applying the polarimetric change analysis over the two separated radar components.

In this contribution, we evaluate forest change following the described Pol-InSAR methodology over different P-band datasets. To this end, data acquired by DLR's airborne F-SAR sensor in the framework of the TMPSAR campaign are used. This campaign covers several years. In particular, multi-baseline fully polarimetric P-band data are available for years 2021, 2022 and, very recently, also for 2023. The test site is located around the temperate forest of Traunstein, in the south-east of Germany. It can be divided into two main forest areas, known as Traunstein and Froschham, for which reference lidar data are available.

The first results of applying the polarimetric change analysis over the separated ground and volume components have proven to be sensitive to forest structural changes. As the most recent works also corroborate [6, 7], the challenge still remains in the interpretation of the nature of such changes. The large wavelength (around 70 cm) of P-band SAR data allows the signal to penetrate into the forest canopy and reach the ground. This leads to a slightly lower entropy scenario when compared to other higher frequencies, as L-band, which makes P-band particularly suitable for the interpretation of forest changes. Different forest change scenarios will be targeted and analyzed in detail, comparing the complementary information between their polarimetric and interferometric signatures. Further results of this study will support the development of strategies to exploit data from the upcoming ESA BIOMASS mission.

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