Monitoring of Plantation Forests using Polarimetric SAR Data

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Industrial plantation forests have rapidly expanded throughout many parts of the world. Therefore, the sustainability of plantation forests must be ensured through continuous monitoring. Especially in regions of persistent water vapor and clouds, which cannot be continuously monitored by optical sensors, microwave sensors are particularly advantageous in forest monitoring. However, microwave backscattering mechanisms in plantations remain poorly understood.
This study attempts to understand backscattering characteristics under different forest structural conditions in plantation forests of fast-growing acacia trees in Sumatra, Indonesia. A general four-component scattering power decomposition method was applied to ALOS PALSAR data. The variation in decomposition powers was compared to forest inventory data with visual assessments of stand conditions.
Our results were highly consistent with the field-measured data and suggest that the forest structural conditions can be understood from the yearly variations of the polarimetric parameters. The main findings are that (1) after the rapid growth phase, when the trees retain fewer leaves, canopy scattering is contributed by both forest canopy and understory vegetation. Four-component power decomposition is useful for distinguishing the growth of the canopy itself from growth of the understory vegetation; (2) in the investigated plantation, the relative canopy scattering increases in healthy mature stands before harvest time because the remaining tree canopy is supplemented by understory vegetation. At the same time, the understory growth strongly interferes with the double-bounce scattering, in which remarkable decrease is observed. This result indicates that the understory conditions must be considered in the analysis of L-band SAR data, especially in this plantation and other sparse forests; (3) physical leaf damage is associated with a distinct decrease in relative canopy scattering, and also by increased relative surface and double-bounce scatterings. Partial damage in a forest compartment is reflected in the ALOS PALSAR data. Moreover, even in younger forest stands, the fluctuation in the canopy scattering reflects the growing conditions, and provides useful information for measuring growth states.
This study on a single-layered forest elucidated how the fundamental characteristics of radar backscattering vary with forest structures and conditions. Such understanding will assist forestry researchers to interpret scattering mechanisms in natural forests.

Keywords: Scattering Power Decoposition, L-band, plantation forests

