The Effect of Vegetation Gaps on Radar Interferometric Returns

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Radar interferometry shows a distinct signature in the estimated height and the channel to channel correlation in the presence of vegetation canopy. To translate these signatures into parameters of biological importance, such as tree height or biomass, requires an inversion process which, often, requires the use of parametric scattering models. In the past, models have mainly consisted of simple layers or ensembles of layers. In some models, a canopy gap fraction is also introduced, but the geometry of the gaps is very simplified.

Recent results, which we will review here, show that the penetration of microwave radiation into the canopy shows little frequency dependence in the wavelength bands between L-band (~25 cm) and X-band (~3 cm). These results cannot be explained easily using conventional continuous models of penetration. In this paper, we argue that the experimental evidence indicates that a frequency **independent** scattering mechanism is responsible for the bulk penetration. One such mechanism is geometric optics, where the penetration into the canopy is governed by canopy gaps (within a single crown or gaps between trees). This model predicts that the degree of penetration should be determined by the structure of the gaps in the canopy, in addition to the dielectric properties of the canopy components.

In this paper, we develop a number of canopy gap structure models and a ray-tracing coherent interferometric scattering simulation to examine the effect of gap structure and canopy roughness on the interferometric phase and correlation. We compare the predicted results against interferometric data collected by the NASA TOPSAR instrument and the GeoSAR interferometer. The canopy characterization is obtained using lidar full waveform data collected by the NASA SLICER instrument. We examine the effect of different canopy structures on the prediction of the interferometric signature and its agreement with the experimental data. Finally, we introduce a non-parametric technique for estimating canopy parameters and relate the non-parametric technique to our theoretical and experimental results.