SAR images simulation of tropical forests at P and L band

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Forest observation with RADAR signals are particularly relevant due to their properties of penetration under foliage. As an example, European Space Agency (ESA) will launch a synthetic aperture radar (SAR) operating at P-Band in order to determine the distribution of above-ground biomass in forests. For such applications it is valuable to model the interaction of electromagnetic waves with forests to interpret the existing airborne or space data and to generate predictive ones. Simulating fully polarimetric and interferometric SAR images require the computation of the electromagnetic field in amplitude and phase for each pixel. From this complex field the backscattering coefficients σ_{0pq} and polarimetric coherences γ_{pq} are derived in each zone of the image, p,q for H or V polarisation. Previous simulators based on a coherent and discrete formulation have been developed to simulate complex scenarios of forest above a flat ground [L. Villard and P. Borderies "backscattering border effects of forests at P band", PIERS Online, Vol. 3, No. 5, 731-735, 2007]. Such codes have proven to be very useful in this case but limitations appear when topography is present. This paper present the improvement of these approaches by taking into account the underlying topography instead of a rough flat ground and being able to follow the canopy heterogeneity.
First, a class of ground triangles from a digital elevation model and pentahedral voxels with the coordinates of their vertices with respect to a reference flat ground is built. Second, the classes of species of scatters present on the scene are defined. Classes of cylinders and ellipsoïds are created and they are characterized by their average dimensions, orientations and radio electric properties. Classes of mixtures of these scatterers are then generated. In each mixture, the volume fraction of each scatterer element of the previous class is given to determine subsequently the extinction coefficient for each mixture. It corresponds for example to different layers of the canopy from the bottom to the top. Finally, the pentahedral voxels are filled with one of those mixtures to construct the scene. In each voxel, the scatterers corresponding to this mixture are located and their characteristics are attributed. For each scatterer, the various complex contributions (volume, double bounce) and the direct ground one are calculated and summed within range/azimuth cells which are independent from the generation step, and later projected on the reference flat ground. After the detailed presentation of the code, first the application to canonical scenes with relief in P and L bands will be presented at the conference. Then, airborne data and short range scatterometer measurements on tropical forest will be compared with the model output including vertical tomography through the use of a descriptive model based on in-situ data.