A HYBRID ALGORITHM FOR ESTIMATING BOREAL FOREST CANOPY PARAMETERS FROM POLARIMETRIC AND INTERFEROMETRIC SAR

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There is a large number of parameters involved in modeling the scattering process from a forest canopy, even if only one mechanism can be identified as predominant and significant. For instance, for a forest with a dense crown layer, the volume scattering mechanism from the crown can be regarded as the main contributor to the total scattered fields, at least at C- and L-bands. Even so, the parameters needed to describe the scattering process are many: crown height, density of branches and leaves, their dielectric constant distribution, their size and orientation distribution, and the underlying topography. Through empirical means, it may be possible to obtain relationships between some of the above parameters. In particular, for a given species, the crown height could be used to obtain the number density and size of the branches and leaves. The independent parameters to be estimated would, therefore, be the crown height, the average dielectric constant of the scatterers (or equivalently, given their size, the average extinction coefficient of the scatterer layer), and the underlying topography (location of base of crown).

Previously, it was shown that polarimetric SAR backscattering cross section data at C- and L-bands can be used to estimate the real and imaginary parts of the dielectric constant of the crown layer scatterers [1], This was done using parametric representations of the scattering process from a numerical discrete-component forest scattering model. The height of the crown layer and scatterer size characteristics were assumed known. It was also shown that the magnitude and phase of interferometric SAR (INSAR) can be used to estimate the crown height given the extinction coefficient of the layer [2]. The approach was to derive a parametric, analytical model based on scattering principles and statistics of scatterers. In this work, a hybrid of the above two methods will be used, where polarimetric C- and L-band SAR data will be combined with the interferometric correlation of C-VV SAR data measured at two ends of a baseline, to simultaneously estimate crown height and the real and imaginary parts of the dielectric constant of the layer's scatterers (branches and leaves). It will be assumed that the underlying surface is flat, although the extension to general topographical characteristics is straightforward in principle, The approach is to initialize an iteration loop with a value of crown layer height. From the empirical species-based relationships (between crown height and branch and leaf characteristics) and polarimetric SAR backscatter data, values for the complex dielectric constant of the volume scatterers are found. These are then used in the INSAR model to obtain an improved estimate for the crown layer height. This value is in turn fed back to the polarimetric data model, and the process continues until the estimated height and dielectric constant values are stable. Data from the BO REAS Southern study area will be used to demonstrate and validate this method.

This work was performed by the Jet Propulsion Laboratory, California Institute of Technology, under contract from the National Aeronautics and Space Administration.

[1] M. Moghaddam and S. Saatchi, "Monitoring tree moisture using an inversion algorithm applied to SAR data," *IEEE Trans. Geosci. Remote Sensing,* submitted 1996.
[2] R. Treuhaft, S, Madsen, M. Moghaddam, and J. van Zyl, "Vegetation characteristics and underlying topography from interferometric radar,'' *Rad. Sci.,* vol. *31,* November 1996.