

# MONITORING CANOPY MOISTURE USING AN INVERSION ALGORITHM APPLIED TO SAR DATA FROM BOREAS

Mahta Moghaddam and Sasan Saatchi  
Jet Propulsion Laboratory, California Institute of Technology  
MS 300-235  
4800 Oak Grove Drive  
Pasadena, CA 91109, USA  
phone: (818) 354-1591, fax: (818) 393-5285, email: mahta@venice.jpl.nasa.gov

During several intensive field campaigns in summer '93 and spring and summer '94, the JPL airborne synthetic aperture radar (AIRSAR) obtained multifrequency polarimetric radar data over various areas in the Canadian boreal forest designated as primary BOREAS study sites. These were part of a major remote sensing effort in BOREAS geared toward studying the interaction of the forest biome and the atmosphere to identify their role in global change. The parameters which could potentially be derived through remote sensing measurements are to be used in forest biogeochemical models to predict the functioning of the forest biome over various time and space scales. Among the important parameters needed in such studies is the canopy moisture content, which is related to the real and imaginary parts of the dielectric constant of canopy components (leaves, primary and secondary branches, etc.).

In this work, the application of an inversion algorithm based on a nonlinear optimization technique to retrieve the real and imaginary parts of the dielectric constant of the canopy branch layer from multifrequency polarimetric SAR data is discussed. The approach discussed here allows for retrieving and monitoring changes in these parameters in a quantitative and systematic fashion using SAR data. Once these are known, the canopy moisture content can be obtained. The inversion algorithm is an iterative procedure and requires a priori estimates of the unknowns as well as knowledge of the stochastic properties of measured data. Parametric models are used to relate the unknowns to SAR data. An optimization technique is then used to obtain the best set of parameters that produce the measured data given the parametric models. These models are derived from a numerical discrete-component forest scattering model for unknowns over specified ranges. The numerical scattering model includes the major scattering mechanisms responsible for the total SAR backscatter. Here, we concentrate on the branch-layer volume scattering mechanism. The parametric models mentioned above are generated for the case where only the complex dielectric constant of branch layer components is allowed to vary while other parameters are assumed known from, e.g., ground-truth measurements. As such, the inversion algorithm is suitable for monitoring changes of dielectric constant and hence canopy moisture content over various temporal scales. The inversion algorithm is tested and verified by using synthetic data initially. It is then applied to actual SAR data. One data set from August '93 and four from April '94 (thaw season) over Jack Pine forests in the BOREAS Southern study site are used to demonstrate the utility of this algorithm. These data provide for both a short-term (four sets in April) and a long-term (August vs. April) observation of the canopy moisture state. The results are in agreement with the expected values, as will be shown in the presentation.

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