

## ESTIMATING SOIL MOISTURE IN A BOREAL OLD JACK PINE FOREST

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Polarimetric P-band All{ SAR data, corresponding model simulations, and classification algorithms have shown that in a boreal old jack pine (OJP) stand, the principal scattering mechanism responsible for radar backscatter is the double-bounce mechanism (tree trunks and the ground [1]). The data to be used here were taken during six flights from April to September 1994 as part of the BOREAS project. The OJP stand, located in the BOREAS Southern study area, is characterized by tall (20m -3011)) trunks, low density ( $0.3/m^2$ ), and a sparse branch layer. The forest floor is covered by a smooth layer of dry lichen. Since the effect of branch layer and ground scattering mechanisms at P-band are shown to be minimal [1], radar backscatter can be described with high accuracy in terms of the parameters contributing to the double-bounce mechanism. These parameters would be the height and diameter distribution of the tree trunks, ground roughness characteristics, and the dielectric constants of trunks and soil. Except for the last two, these parameters can be measured once and assumed constant over the study period starting from the thaw season until the end of the growing season. The dielectric constants, or equivalently moisture contents, of the trunks and soil, however, can change rapidly during this period. To estimate these dynamic unknowns, parametric models of observed radar backscatter for the double-bounce mechanism were developed by using a series of simulations of a numerical forest scattering model for a wide range of dielectric constant values. The resulting; quad-pol simulated data are used to derive polynomial fits of backscattering cross section as a function of the ground and trunk dielectric constants. Empirical and field data are used to relate the real and imaginary parts of the dielectric constants, and hence formulate the parametric model in terms of two unknowns only. With the three data channels (P-band HH, VV, and HV), it will be possible to solve for the two unknowns. A nonlinear optimization procedure is used to estimate the dielectric constants, and hence, in particular, soil moisture. Ground truth data, to the extent available, are used to verify the results of the estimation algorithm.

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- [1] M. Moghaddam and S. Saatchi, "Analysis of scattering mechanisms in SAR imagery over boreal forest: Results from BOREAS'93," *IEEE Trans. Geosci. Remote Sensing*, vol. 33, no.5, pp. 1290-1296, September 1995.