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Retrieval of forest canopy parameters for OTTER using an optimization technique

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ABSTRACT

An inversion algorithm based on a nonlinear optimization technique is used to retrieve a subset of forest canopy parameters that can be used in ecosystem modeling. The inversion algorithm uses a parametric model derived from a discrete component forest scattering model which includes all major scattering contributions to radar backscatter. The parametric model, however, is derived for cases where only one mechanism dominates the scattering process, in this case, branch layer volume scattering. The free parameters are taken to be the real and imaginary parts of the dielectric constant of branch layer constituents. The parametric model and the inversion algorithm are validated with synthetic data and applied to two data sets taken at different dates over one of the OTTER sites (Santiam Pass). The inversion algorithm is shown to be a useful tool in the quantitative monitoring of canopy moisture status, as well as a building block of its future versions which will include a more comprehensive set of forest scattering parameters as unknowns.

1. INTRODUCTION

During the Oregon transect ecosystem research (OTTER) project, several remote sensing instruments, including the NASA/JPL AIRSAR, acquired data over a variety of forests in western Oregon in June and August 1990 and March 1991[1]. The areas ranged from the dense forests of the coastal region to the sparse inland Juniper forests. Representative ground truth measurements were obtained simultaneously over the same areas. The remote sensing measurements were performed to study the feasibility of obtaining appropriate forest parameters that could be input to an ecosystem model that predicts the daily, seasonal, and yearly production of key nutrients. These are quantities such as biomass, leaf area index, and canopy moisture content.

In this work, we focus on the airborne SAR data, which are C-, L-, and P-band polarimetric microwave backscatter measurements. Several researchers have devised methods to relate forest biomass to radar backscatter for specific forest stands and with varying degrees of accuracy[2,3,4]. These results are potentially of great practical value. In a previous paper, we have reported the dependence of radar measurements on forest biomass for the forests under study in OTTER[5]. In the same work, we have concluded that quantitative relations between radar backscatter and compound quantities such as biomass cannot be directly found in a unique fashion, and it is advantageous to study the radar measurements as functions of electromagnetic scattering properties of forest canopy components, such as dielectric constant of tree and ground constituents and their structural and size properties.