Estimating Boreal Forest Carbon Stock by Multitemporal Spaceborne Radar Imagery

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Abstract

One of the major signals of the climate change is observed in the northern hemisphere. The increase of atmospheric CO2 and the rise of temperature have impacted the seasonality of the ecosystem and its trace gas exchange with the atmosphere. Measuring the existing carbon stock in the vegetation of boreal zone, its spatial distribution, and its changes due to climate and human activities are the most urgent and challenging scientific problems in global carbon cycle. In this paper, we investigate the use of existing spaceborne radar images at L-band and C-band frequencies to estimate the above ground biomass of vegetation and its changes in the boreal forest ecosystems. A semi-empirical fusion algorithm is developed using multitemporal JERS-1 and ERS images to separate major structural components of the forest and to estimate the above ground biomass (AGB). The methodology combines radar backscatter models, land cover structural classification, and ground field surveys to estimate the contributions of the moisture and structure in radar measurements. The algorithm is applied on images acquired over a site in the boreal forest of Canada during the growing season. The multitemporal images provide the key information to estimate the rapidly varying backscatter component related to the moisture. The estimation of AGB was compared with field data over more than 60 test sites of various forest stands in the study area. The accuracy of estimation and the robustness of the algorithm are discussed in terms of errors in field measurements and the radar backscatter calibration. The improvements of the estimation approach are also examined when more radar channels become available from the future spaceborne SAR systems such as in ALOS, Envisat, and Radarsat missions.

Keywords: SAR, Boreal Forest, Biomass, and Fusion

This work is performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract from National Aeronautic and Space Administration.