Estimating Forest Vegetation Variables by Combining INSAR and POLSAR Data and Minimizing the Need for Ancillary Data

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A unified algorithm is developed to simultaneously estimate forest vegetation height, stem number density, and canopy moisture from interferometric SAR (INSAR) and polarimetric SAR (POLSAR) data. The only ancillary information needed is the knowledge of tree species type, assuming allometric equations relating several canopy variables to tree height exist and are known. For a given species, among the variables determined by tree height are stem diameter and branch layer geometrical characteristics. These variables, along with stem number density and canopy moisture characteristics, are needed to describe the INSAR and POLSAR scattering processes, and hence to devise the estimation algorithm for the three variables identified above.

Previously, we have developed independent algorithms for estimation of vegetation heights using INSAR [1] and canopy moisture using POLSAR [2]. The former assumed the knowledge of canopy extinction characteristics (moisture, branch-layer geometry, and number density) when using a single interferometric baseline, whereas the latter assumed the knowledge of geometrical properties of the canopy (height, branch-layer geometry, and number density). Both algorithms developed parametric, analytically based models using scattering principles and statistics of scatterers, which could readily be used in nonlinear estimation procedures. In this work, the independent INSAR and POLSAR forward scattering models are modified so that both use a unified set of variables in their formulations. Three independent variables are estimated, namely, tree height, canopy moisture, and stem number density. The forward scattering parametric models remain the same as those used in [1] and [2], but the synergistic expanded data space thus enables the estimation of a larger number of variables, while reducing the amount of necessary ancillary data. C-band POLSAR and single-polarization single-baseline INSAR, together with ground measurements from BOREAS are used to demonstrate this algorithm. Several stands of varying heights and densities are included and error distributions are reported. Addition of other frequencies and polarizations will strengthen this algorithm and are planned as future activities.

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

REFERENCES

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