Preferred "J'epic: Remote Sensing techniques & instrumentation: Interferometry
Presentation Preference: Oral

ESTIMATING VEGETATION AND SURFACE TOPOGRAPHIC PARAMETERS FROM MULTIBASELINE RADAR INTERFEROMETRY

Robert Treuhaft, Mahta Moghaddam, Sasan Saatchi, Jakob van Zyl
Jet Propulsion Laboratory, MS 300-235
California Institute of Technology
4800 Oak Grove Drive
Pasadena, California 91109
Phone: (818)354-6216, Fax: (818)393-5285,
email: Bob_Treuhaft@radar-email.jpl.nasa.gov

and Kamal Sarabandi, University of Michigan, Ann Arbor, MI 48109
Phone: 313-936-1575
mail: saraband@eecs.umich.edu

Interferometric synthetic aperture radar (1 N SA R) data are sensitive to the vertical structure of vegetation and the underlying surface topography, both of which are of critical importance in successional ecological modeling and hydrology. In order to estimate vegetation and surface topographic parameters from INSAR, a physical model relating, the INSAR data to the properties of the vegetation and surface topography must be used. The simplest such model is that of a homogeneous vegetation layer on lop of a ground surface. Even with this simple model, the number of parameters needed to describe the veget at ion 1 ayer and under] ying topography is greater than the number of independent observations, for sillglc-baseline, single-frequency, single-polarization, single-incidence-angle INSAR. For example, if the 1) amplitude and 2) phase of the INSAR cross-correlation are regarded as the two independent INSAR observations, the parameters needed to describe these observations, in a homogeneous-layer model, are 1) depth of the vegetation layer, the 2) extinction coefficient (power loss per unit length), ant] the 3) altitude of the underlying ground surface. Although demonstrations with INSAR data and ancillary extinction coefficient data have shown that the performance of the estimates of the other two parameters is potentially at the few-mete.r level, the INSAR data alone are insufficient to extract the parameters mentioned above. In this paper, we therefore demonstrate that data taken simultaneously from two INSAR baselines will enable the estimation of all three of the above parameters without any additional information.

The potential of multibaseline INSAR will be demonstrated theoretically and with data. The theoretical demonstration will show, for example, that increasing the nominal TOPSAR baseline of 2.5 m to 5 m significantly reduces the normalized cross-correlation amplitude by 2-3% for vegetation layers 20-30 m tall. This decrease in cross-correlation amplitude and the ;ross-correlation phase change due to the longer baseline show that the diversity of INSAR responses with multiple baselines may help to uniquely estimate vegetation and surface topographic parameters. Data from two baselines can be acquired with the JPL 'I'C)}'SAl< system by simultaneous] y operating with two transmit-receive configurations: 1) Transmit from one end of the baseline and receive that signal at both ends, and 2) transmit from both ends of the baseline and receive from both ends of the baseline. Cross-correlations of signals received at both ends of the baseline, which were transmitted from only one end (case 1), are characterized by a phase proportional to the physical baseline, which is 2.5 m. Cross-correlations of signals transmit ted and received at both ends (case 2) are characterized by a phase proportional to t wice the physical baseline. This "ping-pong" approach is used for TOPSAR data taken over the Boreal forests and the Kellog site in Michigan. The cross-correlation amplitude and phase differences between baselines will be discussed, and the complete set of parameters mentioned above will be estimated and compared to ground truth.