ACCURACY IMPROVEMENT OF MAXIMUM LIKELIHOOD INVERSION OF FOREST HEIGHTS WITH POLINSAR DATA

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Polarimetric synthetic aperture radar interferometry (PolInSAR) is a perspective remote sensing technique that has been intensively used for extracting forest heights. There are many forest parameter inversion methods. Among these methods, maximum likelihood inversion method computes the maximum-likelihood estimate of the vegetation parameters based directly on the sample coherency matrix [1, 2]. Moreover, the formula for the coherency matrix of vegetated area was predicted by the model of Treuhaft and Siqueira [3], which is random volume over ground model (RVoG). It is obvious that the estimation of sample coherency matrix is of great importance in this inversion process. A coherency matrix estimation method based on the PolInSAR coherence region shapes is presented in this paper.

According to the model derived in [3], the complex interferometric coherence for a random volume over a ground can be written as the equation of a straight line in the complex unit circle. That is, in the absence of noise, decorrelation and sampling error, the coherence region is a straight line segment whose location and orientation depend on canopy height, attenuation and bare-earth height. Therefore, the closer the shape to a line, the better PolInSAR data fit the model. In [4], a numerical approach for calculation of the shape and distribution of all complex coherence with equal scattering mechanisms is presented. The shape structure is complex and it is approximated through an ellipse. Moreover, some coherences shape parameters are derived. Among these parameters, a parameter named outward tendency is introduced to represent the trend of the ellipse outwards. Lower the outward tendency value corresponds to more convergent coherence region.

Usually, coherency matrix of PolInSAR data are estimated by boxcar average: a number of neighboring pixels are averaged to yield an estimate of the coherency matrix. However, boxcar filter has the deficiency of indiscriminate averaging of neighboring pixels [5], which will cause bias to the estimation of coherency matrix. In order to solve this problem, adaptive edge-aligned average windows [6] derived from the outward tendency parameter of coherence region shape are proposed to help accurately estimate the coherency matrix and consequently improve the accuracy of maximum likelihood inversion results.

The procedure of sample coherency matrix estimation is as follows:

1) Estimate the sample coherency matrix with boxcar average, and then estimate complex interferometric coherence of

different polarization channels, where the scattering mechanisms of master and slave images are constrained to be the same.

2) Construct a series of edge-aligned average windows according to the size of boxcar averaging window.

3) Estimate outward tendency parameter from the coherence values, and compare the parameter value with a threshold. If the value is lower than the threshold, keep the estimated coherency matrix. On the contrary, if the value is higher than the threshold, calculate a sequence of coherency matrices and complex coherence values averaged with the edge-aligned windows, and estimate a sequence of new outward tendency parameters from these coherence values. The edge-aligned window, which corresponds to the minimum outward tendency, is the selected average window. Consequently, the coherency matrix can be estimated with the average window.

Since coherency matrix is estimated, forest heights can be successfully retrieved according to the method introduced in [1, 2]. In order to confirm the validity of the proposed method, simulated L-band PolInSAR data provided by ESA is used. Experiment results suggest that this method can help improve the accuracy of maximum likelihood inversion of forest heights.

References

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