TREE HEIGHT RETRIEVAL METHODS USING POLINSAR COHERENCE OPTIMIZATION

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1. INTRODUCTION

Forest height extraction with polarimetric interferomtric SAR (POLInSAR) is a hot research field of imaging SAR remote sensing. Several available forest height inversion methods using POLInSAR data, such as SINC, DEM and PCI method [1], were validated and compared with repeat pass E-SAR datasets and the corresponding ground measured forest stand height. Inversion results of the tree height with these methods contain some error because of the assumption that the ground-to-volume scattering ratio in the HV channel is 0 and maximum in the HH-VV channel [2]. Here we propose coherence optimization techniques to resolve the problem. Optimal scattering mechanisms and stable interferometric coherence for specific application can be obtained by an effective optimization method which suits the application needs [3].

2. METHODS

Which coherence optimization algorithm is better suitable for the specific height inversion method? Which inversion method is the better suitable for height extraction with the DLR E-SAR L band data of the Traunstein test site?

At first, Forest height inversion method only based on coherence amplitude information is introduced. The iteration for the maximization of the magnitude difference (BF-mag) coherence optimization algorithm and phase diversity (PD) coherence optimization algorithm [4] are used to validate capability of coherence optimization technique to improving performances of the inversion method. Secondly, height estimation method using coherence phase information alone and coherence optimization method are discussed. Finally, an integrated inversion method, combining coherence phase with coherence amplitude information, including corresponding polarization coherence optimization and compensation of non-volume scattering decorrelation, is proposed.

3. EXPERIMENT RESULTS AND CONCLUSIONS

The DLR E-SAR L band data of the Traunstein test site is used to illustrate the performance of these methods. Table 1 demonstrates some quantitative results. Figure 1 shows forest height slice profile along the azimuth direction （No.278 column）obtained by the three inversion algorithms involved in the paper. Experiment results show that coherence phase optimization can improve the performance of the retrieval method based on coherence phase information alone, but can not improve the performance of the retrieval method only based on coherence amplitude information. However, the effect of coherence amplitude optimization on that of retrieval method is just the opposite. Furthermore, the PD algorithm could ensure best phase separation between any coherence values and effectively improve the estimation accuracy. The computational efficiency and numerical stability of the PD algorithm is superior to the BF-Mag algorithm for POLInSAR measurement data. In conclusion, by including decorrelation sources and corresponding coherence optimization algorithms, result accuracy of above forest height inversion methods is improved, and the general performance of the integrated forest height inversion method is superior to the others.

Table 1 Comparison of some inversion results

Inversion Method used	Average deviation (m)	The square of correlation coefficient (R^2)	Root mean square error(RMSE)（m）
DEM difference，HV、HH-VV channel	-24.528	0.280	25.245
DEM difference，PD channel	-21.8909	0.499	22.530
DEM difference，BF-Mag channel	-27.862	0.253	28.672
SINC inversion，HV channel	15.867	0.767	16.412
SINC inversion，PD channel	15.932	0.751	16.470
SINC inversion，BF-Mag channel	11.984	0.766	12.569
Phase + amplitude inversion，HV、HH-VV channel	0.255	0.338	5.895
Phase +coherence inversion，BF-Mag channel	-3.179	0.247	14.126
Phase +amplitude inversion，PD channel	3.510	0.683	5.231
Phase + amplitude inversion，PD channel，non-volume scattering decorrelation factor	1.016	0.811	3.352

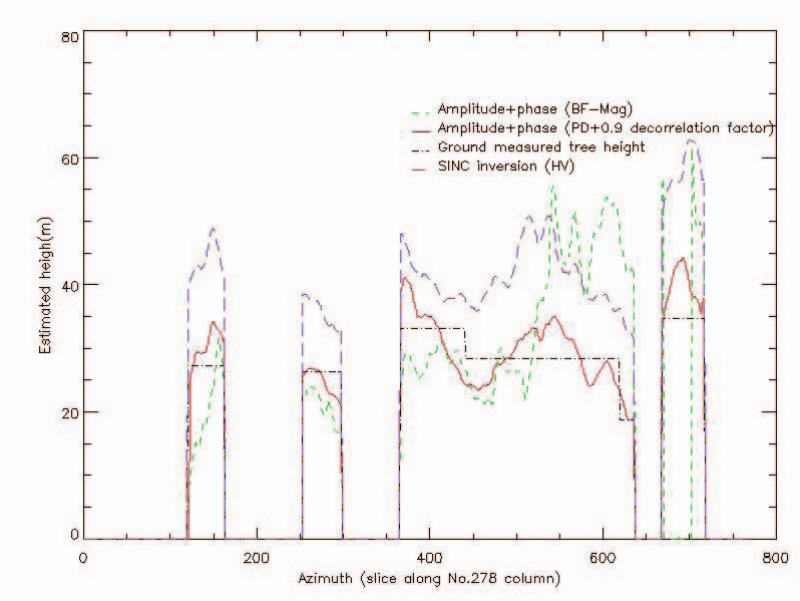

Figure 1 Forest height slice profiles along the azimuth direction （No.278 column）respectively corresponding to the three inversion algorithms; Long dashed line: SINC inversion, HV channel; Solid line: Phase + amplitude inversion, PD channel， non-volume scattering decorrelation factor; Dashed line: Phase +coherence inversion, BF-Mag channel; Dashed dotted line: the field measured average tree height

4. REFERENCES

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