TEMPORAL DECORRELATION STUDIES FOR VEGETATION PARAMETER ESTIMATION WITH SPACEBORNE RADARS

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1. INTRODUCTION

Repeat Orbit interferometric synthetic aperture radars (InSARs) are useful for providing estimates of vegetation characteristics, topographic maps, ground swell, ice deformation etc. An interferometer makes use of phase information between two spatially separated antennas to map height changes and topography of the surface. The separation of the two antennas is called the baseline. The accuracy of height information obtained from an interferometer depends on the spatial extent of the baseline. For a fixed signal to noise ratio smaller baselines, in wavelengths, result in lower accuracies of height estimates. Getting good estimates of height from an instrument operating on lower frequencies, on the order of GHz, would require baselines that are physically very large and make a two antenna instrument aboard a satellite too expensive and complicated. Repeat orbit interferometers use two nearly identical passes of a single antenna SAR to form an interferogram and derive height estimates. Such systems are physically realizable and less expensive. Moreover, they provide means of determining height changes over the duration of repeat pass of the satellite using decorrelation information in radar echoes. InSAR measurements are also invaluable in determining vegetation characters, such as tree height, structure and biomass. They can provide extensive coverage over vegetated areas. Decorrelation in interferometers, however, adds uncertainty to these estimates. It can be attributed mainly to change in radar geometry, different additive noise, and changes in the observed scene over time. In fact, the total observed correlation can be written as

$$\rho_{total} = \rho_{temporal} \cdot \rho_{SNR} \cdot \rho_{geom}$$

Where $\rho_{tempral}$ refers to decorrelation due to change in the target over time and ρ_{SNR}, ρ_{geom} correlation effects due to additive noise and slight changes in radar observing geometry, respectively.

Temporal decorrelation plays a significant role the performance of estimators of vegetation parameters. Changes in radar echoes from forests over time can be attributed to various phenomena such as seasons, vegetation type etc. As well as estimating vegetation parameters, designing an interferometer system for this purpose requires understanding of the effects of temporal decorrelation. In order to better qualify system parameters such as orbit repeat times, operating frequency, knowledge of $\rho_{temporal}$ becomes crucial.

In this text we look at effects of temporal decorrelation over vegetated areas from a large data set as a near best case scenario for minimal temporal decorrelation. The data set analyzed here was collected by the shuttle mission SIR-C and covers a large swath, around 1.7million hectares, over the eastern US with a repeat period of one day and a perpendicular baseline varying from 30m to less than a meter.