EXTRAPOLATION OF FOREST STRUCTURE ESTIMATES THAT USED SAR AND LIDAR TO AREAS WITH NO LIDAR

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ABSTRACT

The horizontal and vertical (3D) structure of Earth's forested ecosystems are of great significance to their ecological functioning and societal uses. Recent research suggests that using LIDAR, SAR, INSAR and optical multi-spectral (VIR) together can allow one to obtain accurate estimates of parameters for forest 3D structure and biomass. However, the spatial coverage that can be expected of a spaceborne LIDAR in the near future is not continuous, and so techniques are needed to fill in these holes, or extrapolate across a larger continuous landscape. Using our in-house suite of LIDAR, SAR, INSAR, and VIR simulators, we explore possible algorithms to accomplish this extrapolation process. In particular, we present a Bayesian approach combined with a Markov Random field formulation. The process involves first using the few spots across the landscape where we have data from all four sensors. We then use these estimated forest structural parameters and their spatial locations to estimate these same parameters everywhere across the landscape. Then for each spot where we have data from only three sensors, we also use the estimated forest structural parameters to estimate new forest structural parameters. This estimate is more accurate than the low-resolution estimate we started with.

In order to evaluate this process, the simulators are given a description of a possible landscape, with forest structural parameters co-varying in a natural way. We start with a homogeneous forest, as a basline for comparisons. We then use data from the forestry literature to simulate increasingly heterogeneous forest types to understand the effects of this spatial covariance and heterogeneity on the algorithm. Results are used to evaluate future space-based sensing platforms (eg, DESDynI) targeted at vegetation/forest structure estimation.

Index Terms— SAR, INSAR, LIDAR, VIR, extrapolation, forest structure