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TanDEM-X is a single-pass satellite-borne SAR interferometer [1]. It consists of two almost identical X-band (9.6 GHz) SAR satellites flying in a tight tandem formation. The helical shape of the orbit allows for flexible image acquisition geometry. The primary mission goal of the TanDEM-X system is to acquire a global digital elevation model (DEM). However, TanDEM-X data can also be used for forest mapping. Forest height can be mapped with TanDEM-X interferometry if a high-resolution DEM is available as ground reference. By the removal of a simulated DEM interferogram from the acquired image interferogram, a height difference map is obtained, which in forested regions gives an estimate of forest height [2].

For this work, we have produced forest height maps from TanDEM-X interferometry and lidar DEM over the boreal test site of Remningstorp, situated in southern Sweden. A processing algorithm based on [3] was developed. The general agreement of the TanDEM-X-derived forest height maps and the reference lidar maps is very good, especially for the cases with favourable baseline setup. Best mapping results were obtained with baselines giving height-of-ambiguity (HOA) values between 50 and 80 metres. Larger HOA values result in reduced height precision, which makes forest height maps noisier. Lower HOA values give better height sensitivity, but also an increased risk of phase wrapping and more pronounced baseline decorrelation. Especially in the case of mature forest with a few, tall trees, and a significant vertical scatterer distribution, phase wrapping and baseline decorrelation can cause very low coherence, which results in poor height estimates.

To address this problem, and to improve the general understanding of X-band scattering from forests, a forward model simulating TanDEM-X-derived forest height from small-footprint, high-density lidar height maps is developed. Lidar data over Remningstorp were acquired within the BioSAR 2010 campaign (pixel size 0.5 m x 0.5 m). In the model presented here, each pixel is assumed to be a scatterer. For each resolution cell, a weighted coherent sum of the contributions from all pixels is computed. The weighting factor is a number describing the degree of exposure of each pixel to the incident electric field. It is derived from the distribution of scatterers in the line-of-sight of the radar. This approach makes it possible to model the influence of gaps in forest canopy. Also, non-homogeneities in the canopy are handled. However, since the model uses deterministic forest height maps, analytical treatment of the problem is difficult. In the simplified case of constant forest height, random distribution of scatterers, and exponential attenuation profile function, the model reduces to the well-known random volume over ground model, which can be treated analytically.

References

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