Digital Canopy Modelling from TanDEM-X Interferometry and High-Resolution Lidar DEM: Processing Description, Geocoding Accuracy, and Geometric Fidelity Assessment

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Interferometric TanDEM-X images can be processed to digital canopy models (DCMs) of forests using a high-resolution digital elevation model (DEM). Based on the principles of differential SAR interferometry (DInSAR), ground surface topography influence can be removed from TanDEM-X interferometric height, giving a differential height estimate. This estimate corresponds to the mean elevation of radar scatterers above the ground surface. In case of forests at X-band, the most significant scatterers are located primarily in the canopy. In this paper, procedures necessary to obtain digital canopy models will be presented, and the results will be evaluated in terms of quantitative agreement between the TanDEM-X DCM and a reference lidar DCM. The influence of acquisition geometry on DCM quality will be studied. Also, geocoding accuracy will be assessed using trihedral corner reflectors deployed in the test site of Remningstorp. Scientific TanDEM-X data are provided by DLR in a co-registered slant-range complex format, with accurate orbit vectors, and the first processing step consists of interferogram flattening. The DEM is first resampled to the radar geometry, and a simulated DEM interferogram is computed. The TanDEM-X interferogram is flattened through complex multiplication with the simulated DEM interferogram. Interferometric phase is extracted using an optimal 2π-window in order to minimise phase wrapping. The extracted phase is converted to height using a height-of-ambiguity map computed from the acquisition geometry. A constant offset due to different delays unaccounted for during the flattening process is observed in the height data. This offset is estimated and removed using ground reference points. As a final step, a geometric correction is applied to compensate for the side-looking geometry of SAR. The resulting map is then geocoded to UTM coordinates and compared to the lidar DCM.