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AIRBORNE X-HH INCIDENCE ANGLE IMPACT ON CANOPY HEIGHT RETREIVAL: IMPLICATIONS FOR SPACEBORNE X-HH TANDEM-X GLOBAL CANOPY HEIGHT MODEL

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Abstract. To support international climate change mitigation efforts, the United Nations REDD+ initiative (Reducing Emissions from Deforestation and Degradation) seeks to reduce land use induced greenhouse gas emissions to the atmosphere. It requires independent monitoring of forest cover and forest biomass information in a spatially explicit form. It is widely recognised that remote sensing is required to deliver this information. Synthetic Aperture Radar interferometry (InSAR) techniques have gained traction in the last decade as a viable technology from which vegetation canopy height and bare earth elevations can be derived. The viewing geometry of a SAR sensor is side-looking where the radar pulse is transmitted out to one side of the aircraft or satellite, defining an incidence angle (θ) range. The incidence angle will change from near-range (NR) to far-range (FR) across of the track of the SAR platform. InSAR uses image pairs and thus, contain two set of incidence angles. Changes in the InSAR incidence angles can alter the relative contributions from the vegetation canopy and the ground surface and thus, affect the retrieved vegetation canopy height. Incidence angle change is less pronounced in spaceborne data than in airborne data and mitigated somewhat when multiple InSAR-data takes are combined. This study uses NEXTMap® single- and multi-pass X-band HH polarized InSAR to derive vegetation canopy height from the scattering phase centre height (h_{spc}). Comparisons with *in situ* vegetation canopy height over three test sites (Arizona-1, Minnesota-2); the effect of incidence angle changes across swath on the X-HH InSAR h_{spc} was examined. Results indicate at steep incidence angles ($\theta = 35^{o}$), more exposure of lower vegetation canopy structure (e.g. tree trunks) led to greater lower canopy double bounce, increased ground scattering, and decreased volume scattering. This resulted in a lower scattering phase centre height (h_{spc}) or a greater underestimation of vegetation canopy height given by the single-pass X-HH InSAR data. The opposite effect occurs in the far range ($\theta = 55^{o}$), an increase in volume scattering resulted in more accurate vegetation canopy heights when compared to *in situ* measurements. These findings indicate that incidence angle corrections should be applied to airborne X-HH single-pass InSAR. In contrast, NEXTMap X-HH (multi-pass data) h_{spc} data experienced little or no effect of incidence angle, possibly because NEXTMap is an aggregation of multi-pass flight line strips, which averages data over

several incidence angles. These results may aid in the understanding of potential incidence angle effects in Astrium spaceborne Tandem-X data, which will have global digital surface elevation coverage by 2015.

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