Interferometric Water Cloud Model Inversion of TanDEM-X Data over a Boreal Forest: Implications on Forest Scattering at X-band

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An unsupervised approach to interferometric water cloud model (IWCM) inversion is presented, based on non-linear least squares regression. The proposed approach is used to study the dependence of IWCM parameters describing canopy extinction (alpha), ground-to-vegetation backscatter ratio (rho), zero-height decorrelation (gamma0), and vegetation backscattering coefficient (sigma0veg) against parameters describing system setup and environmental conditions for 87 VV-polarised TanDEM-X acquisitions over the boreal test site Krycklan, situated in northern Sweden.

It is observed that rho decreases with increasing temperature at the scene, from above 2dB for temperatures below -15 deg C to around -3dB for temperatures above 15 deg C, while alpha shows the opposite trend: it is within 0.05–0.1m^(−1) for the lowest temperatures, but typically within 0.08–0.15m^(−1) for the highest temperatures. Also, sigma0veg is lowest for temperatures around 0 deg C and it increases with increasing temperature magnitude. Additionally, gamma0 shows a clear correlation with height-of-ambiguity (HOA), as it decreases from around 1 for HOAs below 40m to around 0.8 for HOAs above 200m.

Biomass estimation performance is also assessed. The root-mean-square deviation (RMSD) between stand-level biomass estimates from IWCM inversion and from in situ measurements is found to lie between 15% and 30% for most acquisitions made at temperatures above 0 deg C and at HOAs below 150m. For HOAs above 150m, the coherence contrast becomes too low for reliable estimation of alpha, which decreases biomass estimation performance. However, the coefficient of determination R^2 is high in both cases, typically between 0.85 and 0.93.