Tropical Forest Remote Sensing of Structure and Biomass over Brazil with TanDEM-X

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TanDEM-X, horizontally and vertically polarized radar interferometric data (InSAR) were taken over Tapajós National Forest in Brazil with vertical wavelengths of 155, 73, and 39 m—corresponding to alpha_z (or kappa_z) of 0.04, 0.09, and 0.16 rad/m, respectively. The area under study is 55 km x 20 km, including primary, secondary, and selectively logged tropical moist forests. Preliminary analyses suggest that X-band interferometric coherence decreases by about 30% (from 0.95 to 0.6 for vertical wavelength of 73 m) with increasing field-measured vertical extent (average heights of 7-25 m) and biomass (10-430 Mg/ha). This decrease in coherence further suggests, as has been observed at C-band, that InSAR is substantially more sensitive to increasing biomass in the high range than SAR. Unlike InSAR coherence versus biomass, SAR power at X-band versus biomass shows almost no trend. Airborne lidar coherence data at the above alpha_z/kappa_z are also shown to decrease as a function of biomass. The lidar decrease is about 15% more than the InSAR, suggesting that lidar penetrates more than InSAR. But this is a preliminary observation, which will be clarified with a calculation showing differences in effective penetration for lidar and InSAR, and the important role that holes/gaps play in high-frequency forest scattering. TanDEM-X phase heights are shown to be near the vegetation-profile-averaged height from field measurements, instead of being at the top heights of the trees, again suggesting that effective penetration, perhaps due to holes, may be substantial at X-band. Current methods for estimating horizontally polarized phase will be shown along with multipol approaches to be tried in the future. The importance of these preliminary results is that X-band InSAR may be useful for structure and biomass estimation, with wall-to-wall coverage. The efficacy of InSAR depends on whether a small number of Fourier components (meaning a small number of baselines or alpha_z's) are sufficient for structure/biomass remote sensing. This preliminary analysis, including the comparison with lidar and field measurements, suggests that X-band InSAR is potentially quantitatively viable for tropical forest remote sensing estimates of structure and biomass.