

Forest Characterisation by Means of TerraSAR-X and TanDEM-X Polarimetric Interferometric Data.

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Tandem-X – successfully launched in June 2010 - forms with TerraSAR-X the first single-pass (single- dual- and quad-) polarimetric interferometer in space. This allows for the first time the acquisition and analysis of Pol-InSAR data without the disturbing effect of temporal decorrelation.

X-band is in general - due to its limited penetration capability into dense vegetation media - a sub-optimal frequency band for global forest structure mapping. However, recent airborne experiments demonstrated a - rather unexpected high - sensitivity of X-band interferometric measurements on forest vertical structure attributes [3] including the potential of Pol-InSAR data inversion at X-band for forest height estimation using the RVoG model [1] over boreal and temperate forest conditions. Of course the ability of estimating height in terms of X-band interferometry depends on the capability of X-band to penetrate into and through the forest layer that directly depends on the density and hence the extinction of the volume layer. There are three thinkable scenarios that can be considered:

1. For sparse forest conditions - as found in boreal forests - X-band penetrates until the ground and the Pol-InSAR signature contains a certain ground contribution. Assuming a Random Volume as described by [1] the amount of ground contribution is polarisation dependent, allowing inversion by means of dual- or quad-polarisation Pol-InSAR acquisitions [4],[2].

2. For denser forest systems X-band may be able to penetrate through the whole volume but the ground contribution in the signal can be (and has been) assumed to be negligible low [2][3]. In this case the polarimetric diversity gets lost as the Pol-InSAR signature is dominated by the (polarisation independent) volume contribution. Assuming this and using a priori knowledge about the phase related to the underlying ground (by using for example an external ground DEM), forest height can be estimated even from a single interferometric acquisition at a single polarisation.

3. Finally, for very dense forest conditions where X-band is able to penetrate only through a fraction of the canopy layer a priori knowledge of the ground topography allows to get forest height estimates from one single interferometric channel.

In this paper first TerraSAR-X - TanDEM-X datasets are analysed with respect to the three scenarios in order to conclude about the potential of the TanDEM-X mission for forest parameter inversion and forest characterisation. For this purpose dual polarimetric (HH/VV and/or HH/HV) datasets from the pursuit monostatic commissioning phase (until September 2010 both TanDEM-X and TerraSAR-X operate in a monostatic mode separated by approximately 20km in along-track that translates in a temporal baseline of approx 3sec.) and the bistatic phase (from October 2010 TanDEM and TerraSAR are flying in a close formation and are operated in a bistatic mode with zero temporal baseline) are used. Data takes are done over several test sites in different forest ecosystems (from boreal to tropical forests). Estimated Pol-InSAR parameter/heights are compared/validated against ground measurements or reference data from LIDAR measurements.

[1] R.N. Treuhaft, S.N. Madsen, M. Moghaddam, and J.J. van Zyl, "Vegetation Characteristics and Underlying Topography from Interferometric Data", Radio Science, vol. 31, pp. 1449-1495, 1996.

[2] I. Hajnsek, F. Kugler, S. Lee, K. Papathanassiou, "Tropical Forest Parameter Estimation by means of Pol-InSAR: The INDREX II Campaign, IEEE Transactions on Geoscience and Remote Sensing, accepted [3] Florian Kugler, Stefan Sauer, Seung-Kuk Lee, Kostas Papathanassiou & Irena Hajnsek, "Potential of TanDEM-X for forest parameter estimation" Proceedings EUSAR 2010, Aachen,