A COMPARATIVE TOMOGRAPHIC EVALUATION OF AIRBORNE MULTI-BASELINE SAR DATA AT P- AND L-BAND

Othmar Frey and Erich Meier

Remote Sensing Laboratories
University of Zurich
Switzerland
E-mail: othmar.frey@geo.uzh.ch

ABSTRACT

In recent years, a number of approaches in order to improve the quality and the performance of tomographic SAR imaging have been proposed (e.g. [1], [2], [3]), mostly using L-band data or simulated data.

In [4] we have proposed a tomographic focusing method entirely based on the time-domain back-projection algorithm, an approach, which maintains the geometric relationship between the original sensor positions and the imaged target and which is therefore able to cope with irregular sampling without introducing any approximations with respect to the geometry. Another distinct feature of the time-domain back-projection approach is that the data are directly focused to the three-dimensional reconstruction grid without intermediate track-wise SLC image generation. In that paper, a first analysis of an airborne tomographic P-band data set consisting of 11 flight tracks flown in a parallel fashion has been presented. The data set is part of an extensive airborne SAR campaign that took place in 2006, where two fully polarimetric tomographic data sets (P- and L-band) were acquired (see Tables 1 and 2). The tomographic focusing quality has been assessed by analysing the impulse response of simulated point targets and an in-scene corner reflector. In addition, tomographic slices of an imaged volume representing a forested area were provided. The dominant double-bounce scattering from ground - tree trunk interactions was well visible. In addition, it could be shown that the geometric localization of the dominant scattering mechanism in the forested parts of the area clearly followed the terrain, which was documented by juxtaposing a digital elevation model and a digital surface model derived from airborne laser scanning with the tomographic slices. A known problem with the pure 3D time-domain back-projection algorithm, however, is that high intensity values are accompanied by considerable sidelobes and ambiguities in the normal direction.

Therefore, in [5], an extension of the time-domain back-projection approach to multi-looking based tomographic focusing methods like standard beamforming and Capon beamforming has been discussed and first results obtained with a simulated and the above-mentioned, real airborne tomographic P-band data set have been presented.

The proposed combination of time-domain back-projection and multi-look Capon beamforming yielded an enhanced suppression of the sidelobes for the simulated point target compared to the pure 3D time-domain back-projection focusing method. However, the focusing performance obtained with an in-scene corner reflector has been found to be inferior to the simulated case, so far. As the P-band tomographic imaging was carried out without additional calibration steps in both cases, [4] and [5], it can be assumed that the inferior focusing quality is most likely due to remaining calibration errors in the steering vectors.

In this paper, we will present our new results as obtained from tomographic imaging of a forested area using the P-band *and* the L-Band data set *after having applied a baseline calibration*.

In particular, a comparative evaluation of the tomographic P- and L-band data sets of the forested area with respect to the main scattering contributions at the different wavelengths will be given. To this end, the data sets were processed onto a 3D reconstruction grid using both, the conventional 3D time-domain back-projection approach, as described in [4], and the combined time-domain back-projection & Capon beamformer, as detailed in [5]. The same procedures are applied to simulated and real point targets in order to assess the tomographic focusing performance.

See Table 1 for the sensor specifications. Table 2 contains a summary of the parameters which characterize the tomographic data sets.

	P-band	L-band
Carrier frequency	350 MHz	1.3 GHz
Chirp bandwidth	70 MHz	94 MHz
Sampling rate	100 MHz	100 MHz
PRF	500 Hz	400 Hz
Ground speed	90 m/s	90 m/s

Table 1. E-SAR system specifications

	P-band	L-band
No. of data tracks	11+1	16+1
Nominal track spacing d_n	57 m	14 m
Horizontal baselines	40 m	10 m
Vertical baselines	40 m	10 m
Synthetic aperture in normal direction L	570 m	210 m
Nominal resolution in normal direction δ_n	3 m	2 m
Approx. unambiguous height H	30 m	30 m

Table 2. Nominal parameters of the tomographic acquisition patterns.

1. REFERENCES

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[4] Othmar Frey, Felix Morsdorf, and Erich Meier, "Tomographic Imaging of a Forested Area By Airborne Multi-Baseline P-Band SAR," *Sensors, Special Issue on Synthetic Aperture Radar*, vol. 8, no. 9, pp. 5884–5896, sep 2008.

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