ACCURATE FOCUSING OF SINGLE-PASS AIRBORNE INSAR DATA AT L-BAND

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1. INTRODUCTION

Focusing of SAR data for interferometric processing not only requires a phase-preserving approach in order to allow exploitation of the interferometric information, it also demands an accurate estimation of the differential phase between the two channels. In an airborne scenario this situation is being complicated by the inevitable presence of platform motion errors, i.e. deviations of the flight track from an ideally linear trajectory. Long wavelength SAR sensors like L-band impose another difficulty, which is the relatively long along-track integration time in order to achieve a decent azimuth resolution. All of these problems have been investigated individually in numerous publications, and we proceed in this paper by jointly analyzing the SAR focusing operation in a single-pass airborne long wavelength situation. This is a new case due to the absence of such a sensor so far, and the main motivation to look into this scenario is that with the advent of the PolInSAR processing technique these sensors are gaining more and more interest. A first example of its kind is Intermap's recently developed L-band quad-pol PolInSAR experimental platform [1]. In our study we have been using test data from this system that had been collected over various sites and revealed processing challenges that are being addressed in this paper.

2. PROBLEM STATEMENT

The raw signal of airborne single-pass InSAR systems at L-band differs from that of more common sensors operating e.g. at X- or C-band in two distinct aspects:

1. the significantly longer wavelength induces a much more pronounced range cell migration of a target's phase history, which in turn requires highly accurate focusing algorithms that can handle the range-azimuth coupling. Use of standard range-Doppler algorithms would lead to defocusing and phase biases that directly impacted the interferometric performance.
2. motion compensation or *mocomp* is, as with every airborne sensor, mandatory, but more challenging for long wavelength sensors as the interferometric baselines are much higher. Standard and efficient single-

line compensation methods would lead to significant antenna displacements from the reference track causing defocusing, phase biases, and channel mis-registration [2].

In this paper we are looking into a combined solution of these aspects. Obviously, the problems are coupled as accurate motion compensation has to be carried out on the range cell migration corrected signal. Therefore standard high performance focusing algorithms like the wavenumber domain or ω-k approaches cannot be used without additional modifications. At the same time, we are interested in a time-efficient solution as our sensor is targeted to be a production system rather than a scientific platform. As discussed in the next section we have been looking at three potential approaches to overcome the limitations with the current solution.

3. APPROACH

We have analyzed in detail the following three techniques to improve the focusing of our airborne single-pass L-band data: the dual-line vs. single-line motion compensation approach, the extended wavenumber domain focusing, and the fast factorized backprojection focusing.

DUAL-LINE VS. SINGLE-LINE MOTION COMPENSATION: Single-line mocomp, i.e. the compensation of both antenna phase center positions to the same mocomp line, is a very efficient technique for short-baseline systems as it comprises image co-registration and flat-earth phase removal in a single processing step. However, for longer baselines the mocomp displacements can become large and subsequently imply FM rate mismatches that lead to various effects like defocusing, phase biases, and channel mis-registration. We demonstrate how a dual-line mocomp approach can mitigate this problem.

EXTENDED WAVENUMBER DOMAIN FOCUSING: Wavenumber domain SAR focusing algorithms are not suited for data that require range-dependent motion compensation, as is the case for most of the high-resolution airborne systems. However, an extension has been proposed to overcome this problem [3]. We evaluate this technique using our L-band single-pass data.

FAST FACTORIZED BACKPROJECTION FOCUSING: A time domain focusing approach based on fast factorized backprojection [4] is supposed to carry out motion compensation and accurate focusing at the same time. We investigate this technique in particular with regard to efficiency in computing time, which is an important factor for systems that are targeted for operational use.

4. EVALUATION

Evaluation of results has been carried out on L-band single-pass data from acquisitions over various test sites in Canada in 2008 [1]. We demonstrate the performance of the different approaches discussed above by looking primarily at point target responses and interferometric phase and coherence. In particular, we analyze the

PolInSAR performance which requires high phase fidelity not only for the interferometric pairs but also for the polarimetric channels.

5. REFERENCES

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