MULTI-PATH CORRECTION MODEL FOR MULTI-CHANNEL AIRBORNE SAR

Muriel Pinheiro, Pau Prats, Rolf Scheiber, Jens Fischer

German Aerospace Center
Microwaves and Radar Institute
Wessling, Germany
pau.prats@dlr.de; rolf.scheiber@dlr.de

1. INTRODUCTION

Reception of multiple reflections in addition to the main direct signal of interest is a nuisance effect for many communication, navigation and radar systems. The multi-path signals originate from the surroundings of the transmitters and/or receivers of these systems. Whenever possible system design ensures that the directions of these multi-path signals are attenuated by the antenna pattern and often circular polarisation is used to obtain additional attenuation.

However, for airborne SAR systems usually linear polarisations are used and the design of the antenna pattern is subject to different design constraints (wide swath coverage, ambiguity rejection). In addition, the mounting of the antennas on the aircraft is subject to further constraints and often multi-path signals cannot be avoided. Leakage between different receive channels/antennas may also occur [1].

In 2007 the new airborne SAR system of DLR was flown for test-purposes with a sub-optimal mount of the antennas inside a Radom beneath the aircraft, where the possibility of multi-path signals has been disregarded [2]. The acquired data sets helped to develop a multi-path model useful for understanding and compensating the disturbing effects, which show up as undulations in magnitude and phase primarily along the range dimension of the image. Results will be presented in this paper for data acquired in along-track interferometric and polarimetric modes.

Improvements in the antenna mount and integration of additional absorbers diminished the encountered problem for the more recent data sets acquired by F-SAR in 2008.

2. THE MULTI-PATH MODEL

A multi-path model consisting of the superposition of the direct signal with a time-delayed and attenuated replica of itself is considered. The received signal is given by:

$$s_i(t) = s_i^{'}(t) + b \cdot s_i^{'}(t - \Delta t_i)$$

b is a complex attenuation coefficient and Δt_i is the time delay of the multi-path signal which is also responsible for an additional phase contribution. In the case of the F-SAR system it was possible to estimate an initial guess of these components from the imaging geometry depicted in Figure 1. Tuning and validation of the model has then been performed subsequently by exploiting the along-track interferometric phase of two receive channels. Basically three parameters were estimated using least square methods: the magnitude and phase of the complex reflection coefficient b at the aircraft fuselage, and the uncertainty in h when locating the antenna phase center.

The along-track interferometric phase before compensation of the multi-path component is shown in Figure 2 (left) and after compensation in Figure 2 (right).

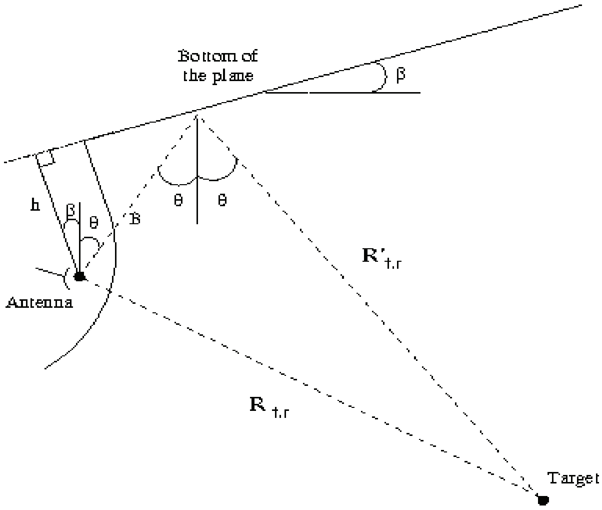

Figure 1: Multi-path geometry for a side-looking antenna mounted below the aircraft. Direct and multi-path signals are indicated.

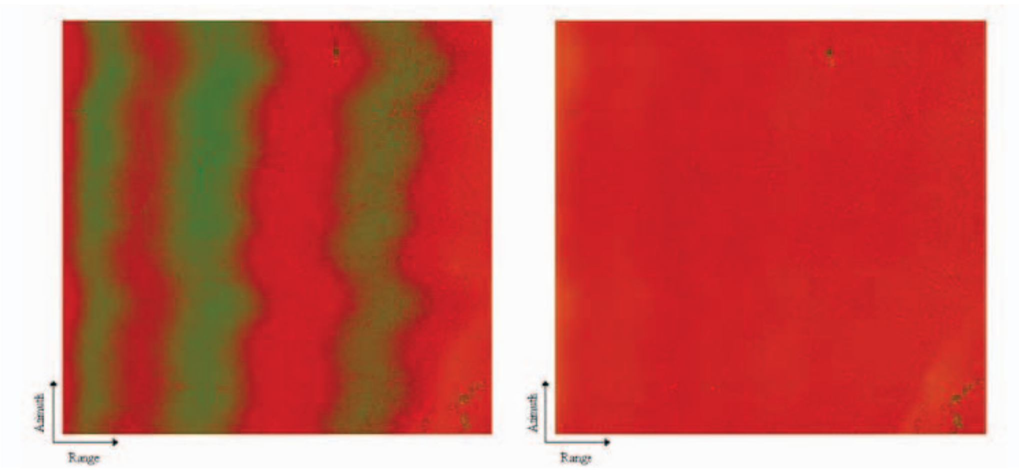

Figure 2: Along-track interferometric phase before and after compensation of multi-path effects. Stationary scene of approx. dimension 3km x 3km.

The paper will present the model and the compensation approach in full detail. In addition, the particularities and results for the polarimetric mode will be discussed.

2. REFERENCES

[1] Madsen, S.N., Skou, N., Woelders, K, and Granholm, J..: "EMISAR single-pass topographic SAR interferometer modes", Proc. IGARSS, Lincoln, 1996.

[2] Horn, R., Nottensteiner, A., and Scheiber, R.: "F-SAR – DLR's advanced airborne SAR system onboard DO228", Proc. EUSAR, Friedrichshafen, 2008