Absolute Radiometric Calibration Approach Using Different Types of Ground Targets

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Abstract. A synthetic aperture radar (SAR) system is a high-resolution imaging radar system which is capable of accurately measuring georeferenced backscatter coefficients in the microwave region. As a measurement instrument, it needs to be calibrated and monitored during commissioning and nominal operation to ensure a high product quality. Different parts of the system require different characterization approaches, and therefore calibration and monitoring is divided into different parts: First, the instrument's state needs to be closely monitored and adjusted, and the respective impacts on the recorded data need to be compensated during data processing. This is referred to as internal calibration. Second, an antenna model needs to be created and verified if the number of beams for a complex SAR system (as one featuring several operation modes) it too large to be characterized manually during the commissioning phase. These steps lead to a relatively calibrated image. In a third step, the image pixel intensities (digital values) need to be bound to physically meaningful backscatter coefficients by means of absolute radiometric calibration. Not until then are measurement results of different modes or systems, for instance, comparable.

The absolute radiometric calibration is usually carried out during the commissioning phase in a field campaign using highly precise point targets (in contrast to distributed targets like the rain forest). Generally, two different types of point targets can be distinguished: Active targets like transponders and passive targets like trihedral or dihedral corner reflectors. Each target type has distinct advantages and disadvantages (e. g. with respect to accuracy, cost, stability, size, and handling), which can best be exploited by using both types side by side during the field campaign.

A major advantage of using two principally different types of targets is the way by which the target's radar cross section (RCS) is determined. For passive targets, this is based on geometrical considerations and can easily be computed. For active targets, it is based on measurements and characterization. Since one yields the RCS of both classes of point targets in an independent way, the calibration of the whole SAR system itself can be validated by comparing the two independent calibrations. Once it has been shown that both approaches (using passive or active targets) lead to the same results within the targeted accuracy, the efforts of the two approaches can be combined to yield a larger total number of measurements which reduces the effect of random errors (averaging). This leads to a highly precise absolute calibration factor, the link between recorded digital values and the physically meaningful backscatter coefficients.

This paper presents the absolute calibration approach using two types of calibration point targets (passive and active), and discusses calibration results on the example of TerraSAR-X.