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Learning from the field of photometry: The way towards better radiometric measurements

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Since the conception of synthetic aperture radar (SAR) systems in 1953, radar cross section (RCS) has been used as the measurement quantity for reporting the backscatter of point targets in SAR images. Consequently, radiometric calibration targets like corner reflectors or transponders have also been characterized by their RCS. This presentation will go into detail why using "RCS" as the measurement quantity should be reevaluated, and how better (standardized) radiometric measurements can become possible in the future.

Parallels will be drawn to the field of photometry in astronomy. In photometry, the intensity of an astronomical object's radiation is measured. In the first half of the last century, measurement passbands (frequency bands) were defined "by chance" through the physical properties of used photographic films, lenses, and so on. In the second half of the last century, more accurate measurements became possible, and standard passbands were developed to allow comparable, repeatable measurements while fully embracing the frequency dependent characteristics of the measurement equipment and calibration objects.

This advancement in methodology lies still ahead of the SAR community. At the moment, radiometric SAR image calibration and radiometric measurements are still influenced by non-standardized factors. As a point in case, the amplitude and phase responses of calibration targets do, with the current state-of-the-art methods, influence the resulting calibration factor. The effects are especially pronounced for current and emerging high-accuracy, high-resolution SAR systems.

As a way forward, the authors propose to introduce a new measurement quantity. Instead of reporting the radar cross section (RCS) of a target, the equivalent radar cross section (ERCS) shall be reported. The ERCS shall be equal to the radar cross section of a perfectly conducting sphere which would result in an equivalent pixel intensity if the sphere were to replace the measured target. This definition allows distinguishing between the body property and the quantity that is actually "seen" by the SAR instrument. The RCS of an object might be (and has been since 1953) approximated by a constant for a low-resolution SAR system; for a modern, high-resolution SAR system, the frequency and aspect angle dependent RCS of a target simply cannot be summarized in a single figure anymore. Furthermore, RCS is defined as a ratio of powers alone, whereas the pixel intensity in a SAR image also depends on the target's phase response due to the processing in the complex domain.

The authors believe that a discussion of current radiometric measurement praxis is necessary and a prerequisite for higher quality, comparable measurements with low to very high resolution SAR systems. The introduction of equivalent radar cross section as the new measurement quantity is an important first step in this direction.