Calibration Concepts for Future Low Frequency SAR Missions

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Several new SAR missions are considered operating at – for the SAR community - low frequencies. Tandem-L is a future SAR mission of the DLR consisting of two identical fully polarimetric SAR satellites which are using a parabolic reflector fed by an active phased array antenna. The combination of digital beamforming techniques for the feed system combined with a large reflector is used to follow the radar pulse in fast time - a technique called scan-on-receive (SCORE). Based on this concept the SAR instrument maps swath widths of up to 350 km. This unprecedented imaging capacity enables weekly observations of dynamic processes on the Earth surface.

Biomass is another upcoming mission which is part of ESA's Living Planet Program. It is designed to provide the scientific community with maps for tropical, temperate and boreal forest biomass which are needed to understand the global carbon cycle. This mission will be the first spaceborne P-Band SAR sensor. It also employs a large reflector antenna, but with an ordinary feed.

Due to the required offset geometry between the feed and the reflector considerable cross-polarization is intrinsically generated in the antenna of both missions. To still achieve the stringent calibration requirements for the missions new calibration concepts have to be developed. The well-proven calibration approach based on an antenna model [1], [2] might be an efficient solution for this problem. It allows predicting the two-dimensional antenna radiation pattern (amplitude and phase for both co- and cross-polarization) from simulations. As for conventional phase array antennas the effort in the commissioning phase could then be reduced to the verification of this model. But in case of Tandem-L the model has to be extended further to include the digital beam forming.

The large size of the reflector is also challenging with respect to required stiffness of the antenna structure. Even small deformation can result in notable errors in the antenna pattern and beam pointing knowledge. Algorithms to estimate beam pointing between or even during acquisition may relax to requirements on the antenna structure saving weight and costs.

Furthermore, the influence of the ionosphere is another challenge at these low frequencies. Geometric calibration is affected by ionospheric delay, while Faraday rotation is influencing polarimetric calibration. The Faraday rotation in P-band can be higher than 360° at high latitude and still some dozens of degrees at L-band. Only near the equator the effect of Faraday rotation can be partly neglected, which constrains the selection of suitable calibration sites. Reference measurements e.g. using GNSS might be used to estimate the properties of the ionosphere.

This paper will present a brief overview of the proposed low-frequency SAR missions, their calibration requirements and will describe techniques tackling the challenges faced by the missions.

References

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