RAIN IMPACT ON SENSITIVITY OF KA-BAND SCAN-ON-RECEIVE SYNTHETIC APERTURE RADARS

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1. ABSTRACT

In the recent years the exploitation of high resolution imagery from spaceborne synthetic aperture radars has grown dramatically. Recent European X-band synthetic aperture radar images are being exploited for new applications never addressed before with radar products.

Nowadays, the possibility to extend the operation frequency for spaceborne radars to higher bands is being taken under consideration. In this context, the high bandwidth available at Ka-band could pave the way for the developments of high resolution spaceborne radars. Airborne or UAV Ka-band synthetic aperture radars have been already developed mainly for military applications such as reconnaissance or surveillance. In addition, the adoption of Ka-band active sensors has been recognized as very promising for accurate ice and snow monitoring. A Ka-band SAR would also allow reducing payload mass, size and, in particular, antenna aperture dimensions. At this frequency band single pass interferometry could also be performed allowing the generation of precise digital elevation models.

Generally speaking, one of the major advantages of imaging radars is the possibility of providing good quality and high resolution images for almost all weather conditions. Unfortunately nowadays one of the major concerns of the effectiveness of spaceborne Ka-band SAR is the impact of the propagation path on the transmitted signal.

For conventional radar, the coupling between average radar return and meteorological parameters arises trough two factors: the effective radar reflectivity, \( Z_e \), and the two-way attenuation \([1]\). In presence of rain, both the mentioned factors can limit significantly the radar performance and of course, availability. Therefore, in order to evaluate accurately the radiometric performance and resolution of a Ka-band SAR a careful and systematic analysis of the impact of weather conditions has to be carried out.

In order to counteract atmospheric effects, and to guarantee a sufficient signal-to-noise ratio, a scan-on-receive SAR is being envisaged as a potential candidate for spaceborne Ka-band radar imaging. The scan-on-receive synthetic aperture radar is essentially based on the separation of transmitting and receiving radar antenna apertures \([2]\). The along track antenna size fixes the azimuth resolution while the transmit aperture dimension determines the across track swath of the radar. On the other hand, in order to increase the sensitivity, the receive aperture is increased, guaranteeing higher gain. The resulting receiving narrower beam is therefore scanned in order to follow the pulse propagation along the across track swath. Compared to state- of-the-art SAR utilizing broad beams without scanning, the scan-on-receive technique with narrow beam reduces significantly the rain clutter interference.

This paper analyses the radiometric performance of a spaceborne Ka-band SAR scan-on-receive outlining the major limiting factors for the design of this instrument.

The instrument sensitivity has been evaluated considering a figure-of-merit that includes the signal-to-noise ratio as well as the signal-to-rain clutter ratio \([3]\). Analytical and numerical simulations have been performed for different rainfall rates, and the instrument availability for given performance is evaluated. Potential instrument configurations and geometric options have been traded-off in order to find the optimal configuration. Comparison with conventional SAR at lower frequencies shows that the scan-on-receive technique is a potential solution for spaceborne Ka-band synthetic aperture radars.
2. REFERENCES