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Radiometric calibration stability assessment of Sentinel-1B using point targets at Surat Basin, Australia

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Research Paper

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Abstract

The launch of the Sentinel-1B satellite in April 2016 completed the two-satellite synthetic aperture radar (SAR) constellation of the European Copernicus Sentinel-1 mission. The European Space Agency executed the calibration of this sensor during the commissioning phase and an independent calibration by the German Aerospace Center (DLR) in 2016. The calibration parameters must be monitored to assess the stability of the instrument. This study reports the temporal stability assessment of radiometric calibration and image quality parameters of Sentinel-1B SAR data using the corner reflector (CR) array, Surat Basin, Australia. Impulse response functions generated from the CRs in the satellite images were used to derive the image quality parameters. The average radar cross-section difference between estimated and theoretical values (38.40 dB m^2) was 0.53 dB m^2 for 1.5 m CRs, which is accordant with the absolute radiometric accuracy specified for the Sentinel-1 SAR system. Derived image quality parameters viz. the mean peak-to-side lobe ratio, mean integrated side lobe ratio, and spatial resolutions in the range and azimuth directions were found to be accordant with the specified value for the Sentinel-1 SAR system. The results indicate the excellent quality of the Sentinel-1B data.

Introduction

Sentinel-1B was launched on April 25, 2016, carries a C-band synthetic aperture radar (SAR) sensor and is a part of the European Union's Copernicus program on Earth observation. This European radar imaging satellite is the second of the two satellites in the Sentinel-1 constellation; the first is Sentinel-1A, which was launched in 2014 [1]. Sentinel-1 SAR sensors can capture multi-frequency, multi-polarized data with different acquisition modes such as the StripMap (SM) mode, Interferometric Wide swath (IW) mode, Extra Wide swath (EW) mode, and Wave (WV) mode. Well-calibrated SAR data are required to compare with SAR data from different sensors and extract the geophysical parameters. Sentinel-1B instrument calibration stability was confirmed during the commissioning phase after extensive ground measurements and calibration campaigns [2, 3]. The German Aerospace Centre (DLR) also performed an independent system calibration in 2016 and confirmed the good performance of the system [4]. However, with time, due to various causes, the sensor tends to degrade. Hence, it is essential to monitor the changes in calibration parameters due to degradation over time. Sentinel-1B data are freely available and currently used worldwide for different applications, such as soil moisture [5], forest height, and aboveground biomass [6]. Hence, radiometric calibration stability monitoring of Sentinel-1B data is required to ensure the reliability of the data. Several studies have been performed to determine the radiometric accuracy and long-term stability of Sentinel-1 SAR systems [7, 8]. In 2020, Schmidt *et al.* [9] analyzed the absolute radiometric accuracy and stability for both Sentinel-1A and Sentinel-1B and compared these derived measurements for an observation period of 2017–2019 [9]. In 2021, Schmidt *et al.* [10] performed an intercomparison of Sentinel-1A and -1B. They found that Sentinel-1B is more sensitive to low-backscatter areas, and no significant radiometric differences are found for point targets and medium-backscatter areas [10]. Miranda *et al.* [11] presented SAR system results focusing on instrument stability, and radiometric and geolocation accuracy [11]. However, to the best of the authors' knowledge, until the submission of the manuscript, no independent quality assessment of the essential quality parameters in the Sentinel-1B SAR sensor after the commissioning phase has been performed. In this study, to ensure the consistency of the radiometric calibration and data quality parameters of Sentinel-1B data, a temporal assessment was performed using a corner reflector (CR) array deployed at the Surat Basin, Australia. This site is maintained by the Australian Geophysical Observing System (AGOS), which offers reliable means to perform radiometric,