

An overview of Sentinel-1 instruments status, L1 product performance and evolutions

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The Copernicus Sentinel-1 (S-1) mission ensures the continuity of C-band SAR observations over Europe. The routine operations of the constellation are on-going and performed at the maximum capacity, allowed by the Sentinel-1A unit, and the new Sentinel-1C unit. Sentinel-1C was launched in December 2025 and successfully completed the commissioning in May 2025. The Sentinel-1B unit has not been operational since December 2021, while the launch of the fourth unit, Sentinel-1D, is planned for late October 2025. The mission is characterized by large-scale and repetitive observations, systematic production and free and open data policy. Sentinel-1 data are routinely used by Copernicus and many operational services, as well as in the scientific and commercial domain. Accordingly, a key aspect of the Copernicus program is the constant provision of quality data, which requires long term engagement to carefully monitor, preserve, and even improve the system performances.

The Sentinel-1 SAR Mission Performance Cluster Service (SAR-MPC) is an international consortium of SAR experts. It oversees the continuous monitoring of the S-1 instruments status, as well as the monitoring of the quality of the L1 and L2 products. This is done by analyzing the variation of key parameters over time using standard products and/or dedicated auxiliary ones. [1].

The monitoring of both the SAR antenna health status and of the SAR instrument is carried out exploiting the dedicated auxiliary products and ensures to minimize degradation of SAR data quality originated by instrument aging or element's failures. The stability of the radiometry is monitored by exploiting the data acquired over DLR calibration sites. In addition to the point-target analysis, gamma measurements over uniformly distributed targets, like rainforest, are used to assess the relative radiometric accuracy of Sentinel-1 products.

The geolocation accuracy is monitored using dedicated acquisitions over corner reflector calibration sites such as Surat Basin, Australia, and includes the compensation of known instrument and environmental effects, e.g., propagation through troposphere and ionosphere or solid Earth deformation signals [2]. The regular monitoring shows extremely good geolocation performances, but also few centimeters of impact by the presently very high solar activity on Sentinel-1 geolocation. A re-calibration of the parameter modeling the fraction of ionosphere below the spacecraft [3, 4] allowed to successfully reduce the degradation, the remaining part is attributed to accuracy limitations in the ionospheric delay corrections applying the GNSS-based Total Electron Content (TEC) maps.

The burst synchronization and interferometric baselines are regularly monitored. The performance is within the specifications for the Sentinel-1C unit and slightly degraded for Sentinel-1A due to the known anomalies in the thrusters and the consequent degradation of the orbit control capacity.

This work will present the status of the instrument and product performance for both the Sentinel-1A and Sentinel-1C units for which the monitoring covers the period successive to the successful closure of the In-Orbit Commissioning. Moreover, the S-1 SAR IPF, the SETAP processor, and the related products continuously evolved to improve the data quality and its usability. Main changes in both processors will be presented, including latest evolution of the ETAD product aiming at increasing the product usability and decreasing its latency.

The quality of the L2 OCN products is also continuously monitored by the SAR-MPC for all the components: Ocean Wind Field (OWI), Ocean Swell spectra (OSW) and Ocean Radial Velocity (RVL). An overview of the L2 OCN calibration status will be presented in this paper, while a detailed discussion of the topic, and the recent evolutions to the Sentinel-1 IPF to introduce the estimation of TOPS cross-spectra will be presented in a dedicated paper.

References

- [1] Sentinel-1 Annual Performance Report 2024, on-line document, <https://sentiwiki.copernicus.eu/web/document-library>
- [2] R. Piantanida et al., "Accurate Geometric Calibration of Sentinel-1 Data," EUSAR 2018; 12th European Conference on Synthetic Aperture Radar, 2018
- [3] C. Gisinger et al., Impact Of 25-th Solar Cycle Ionospheric Activity On Sentinel-1 SAR Data – A Status Report By SAR-MPC, in ESA Living Planet Symposium 2025
- [4] C. Gisinger et al., Refinement of the Bottom-Side vTEC Scaling Parameter for Correcting Ionospheric Path Delays in Sentinel-1 Data, in IEEE International Geoscience and Remote Sensing Symposium 2025

Preferred Contribution Format

Oral Presentation

Suggested Topic(s) of Abstract

Pref-1: Calibration of Running Missions

Pref-2: Calibration Methodology and Techniques