Sentinel-1 instruments status, 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 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.

On the 23rd of December 2021, an irrecoverable incident occurred to the Sentine-1 B unit and on the 3rd of August 2022 S1B end of life has been announced. The mission continues to operate with the Sentinel-1 A unit, and the launch of Sentinel-1C is expected for 2024 (still to be confirmed).

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.

The monitoring of both the SAR antenna health status and of the SAR instrument is carried out exploiting the dedicated auxiliary products to ensure that no degradation of SAR data quality is originated by instrument aging or elements failures. The radiometric performance monitoring exploits both the DLR calibration site, hosting transponders and corner reflectors, and uniformly distributed targets, like rainforest, to assess the absolute and relative radiometric accuracy of S-1 products. The geolocation accuracy is monitored using dedicated acquisitions over additional calibration sites. The procedure includes the compensation of known instrument and environmental effects, e.g., propagation through troposphere and ionosphere.

In general, the performances are considered stable and within specifications. The monitoring of the IW/EW modes burst synchronization indicates a possible degradation starting around autumn 2022. The issue is under current evaluation and corrective measures will be considered, if necessary.

The introduction of a Radio Frequency Interference (RFI) correction step in the Sentinel-1 processing chain, activated on the 23rd of March 2022, has improved the data quality of the affected L1 products. RFI monitoring suggests a typical decrease from 20% to 1% of the total number of degraded slices (i.e., with residual degradation after correction due to either misdetection or limitations of the correction).

The performance of Ocean L2 products derived from data acquired in WV mode has been improved thanks to the deployment of a new configuration for the WV2 beam on the 22nd of June 2021. Moreover, continuous improvement of the L2 algorithms allowed for an improvement in the products usability, e.g., with introduced changes in L2 OSW quality flags.

Finally, important evolutions of the S1-IPF and S1 products have been introduced recently:

- Correction of misalignment between the elevation antenna pattern and the annotated thermal noise vector affecting some GRD products in IPF 3.5.1. Additionally, the correction of an issue leading to missing data in the noise vectors of certain long data takes put in place in IPF 3.6.1.
- Inclusion of "Total" significant wave height (not only from the swell component) as extracted using a Neural Network algorithm trained on altimeter measurements [1] and implemented in IPF 3.5.1 (IPF version from March 2022, activation via configuration change in June 2022).
- A new S1-ETAD auxiliary product has been developed and production started in April. This data provides users with corrections to improve geometric accuracy of Sentinel-1 SLC images to centimetric levels and it is planned to be delivered to users starting in Autumn 2023.

A complete list of the content of IPF versions can be found in https://sar-mpc.eu/ipf/ whereas S1 product quality disclaimers are available in https://sar-mpc.eu/disclaimer/.

This presentation will provide an overview of the status of the Sentinel-1 instrument and product performance, and the recent evolutions.

[1] Quach, B., Glaser, Y., Stopa, J. E., Mouche, A. A., & Sadowski, P. (2020). Deep learning for predicting significant wave height from synthetic aperture radar. IEEE Transactions on Geoscience and Remote Sensing, 59(3), 1859-1867.

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