Copernicus Sentinel-1 - Operational POD and the CPOD Service

ESA Living Planet Symposium 2022

23-27 May 2022, BONN

Jaime Fernández (1)
Marc Fernández (1)
Heike Peter (2)
Pierre Féménias (3)

(1) GMV AD., Tres Cantos, Spain
(2) PosiTim UG, Seeheim-Jugenheim, Germany
(3) ESA/ESRIN, Frascati, Italy

ABSTRACT

The Copernicus POD (Precise Orbit Determination) Service is part of the Copernicus Processing Data Ground Segment (PDGS) of the Copernicus Sentinel-1, -2, -3, and -6 missions. A GMV-led consortium is operating the Copernicus POD (CPOD) Service being in charge of generating precise orbital products and auxiliary data files for their use as part of the processing chains of the respective Sentinel PDGS.

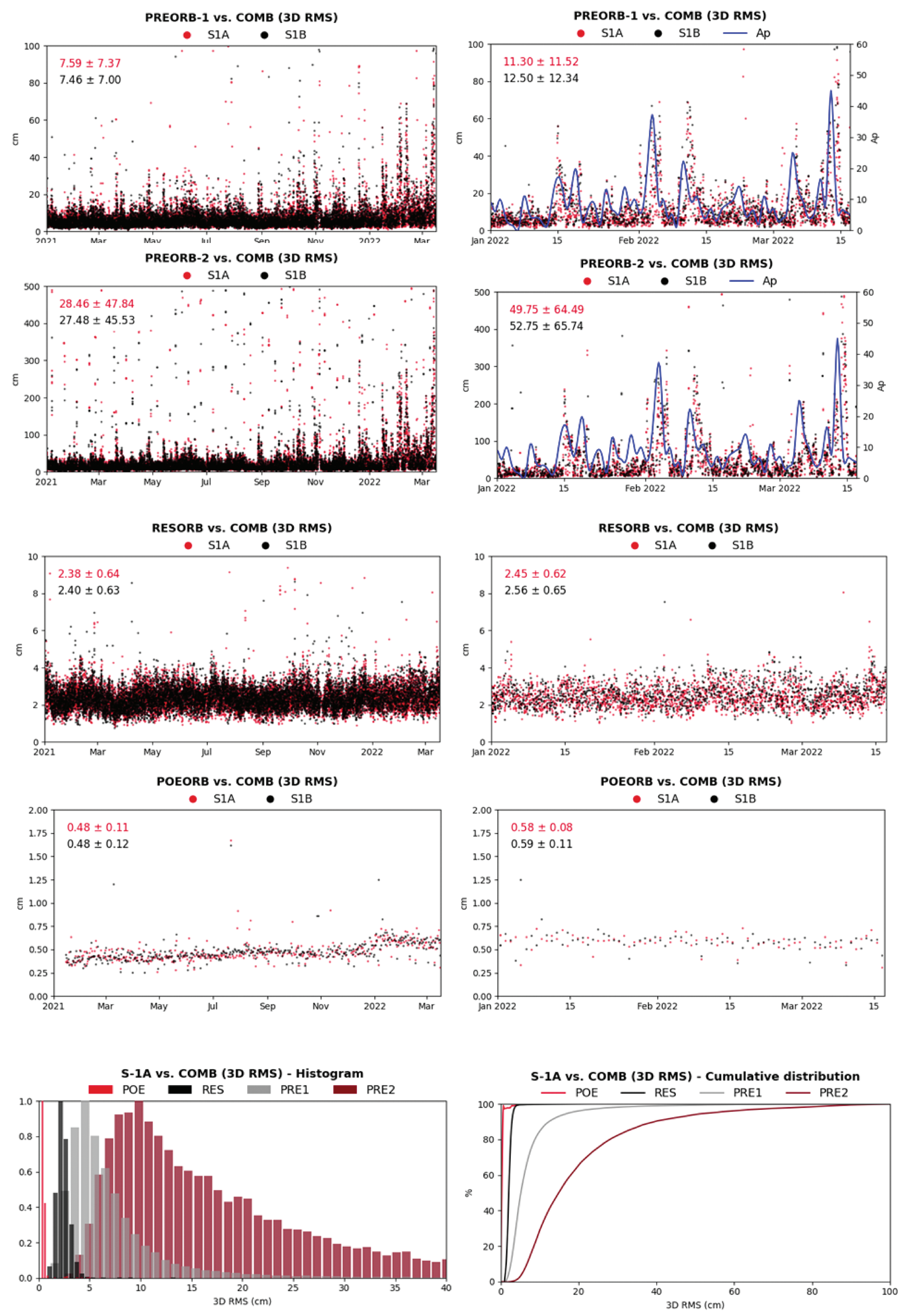
The two Copernicus satellites Sentinel-1A and Sentinel-1B are Synthetic Aperture Radar (SAR) satellites, launched in April 2014 and 2016, respectively. The POD of the satellites is done based on the dual frequency high precision GPS data from the on-board receivers. Three different orbital products are currently provided for both satellites: PREORB, RESORB and POEORB with different timeliness, accuracy and coverage. Since beginning of 2020 the new PREORB product is generated to be used instead of the on-board navigation solution; this new product has a latency of maximum 30 minutes, and an accuracy requirement better than the on-board solution (1 m in 2D). It provides a propagation of four orbital revolutions to the future, from the last ascending node. The near real-time (NRT) RESORB product has a latency of maximum three hours and an accuracy requirement of 10 cm in 2D. The non-time critical (NTC) POEORB product has a latency requirement of less than 20 days and a very high accuracy requirement of 5 cm in 3D.

The orbit accuracy validation is mainly done by cross-comparing the CPOD orbits with independent orbit solutions provided by the CPOD Quality Working Group (QWG). This is essential to monitor and improve the orbit accuracy, because for Sentinel-1 this is the only possibility to externally assess the quality of the orbits. Typical differences with respect to external solutions are well below the requirements.

In April 2021 a reprocessing of the orbits from the entire mission times of both satellites has been published on the ESA Copernicus Open Access Hub. The aim of the reprocessing is to p rovide a consistent set of orbits to the user community for the full mission triggered by several major updates in the operational orbital processing during the last years.

This paper presents the Copernicus POD Service in terms of operations and orbital accuracy achieved for all orbital products of Sentinel-1A and -1B. Focus is given to the new orbit prediction product (PREORB) and the reprocessed orbital product.

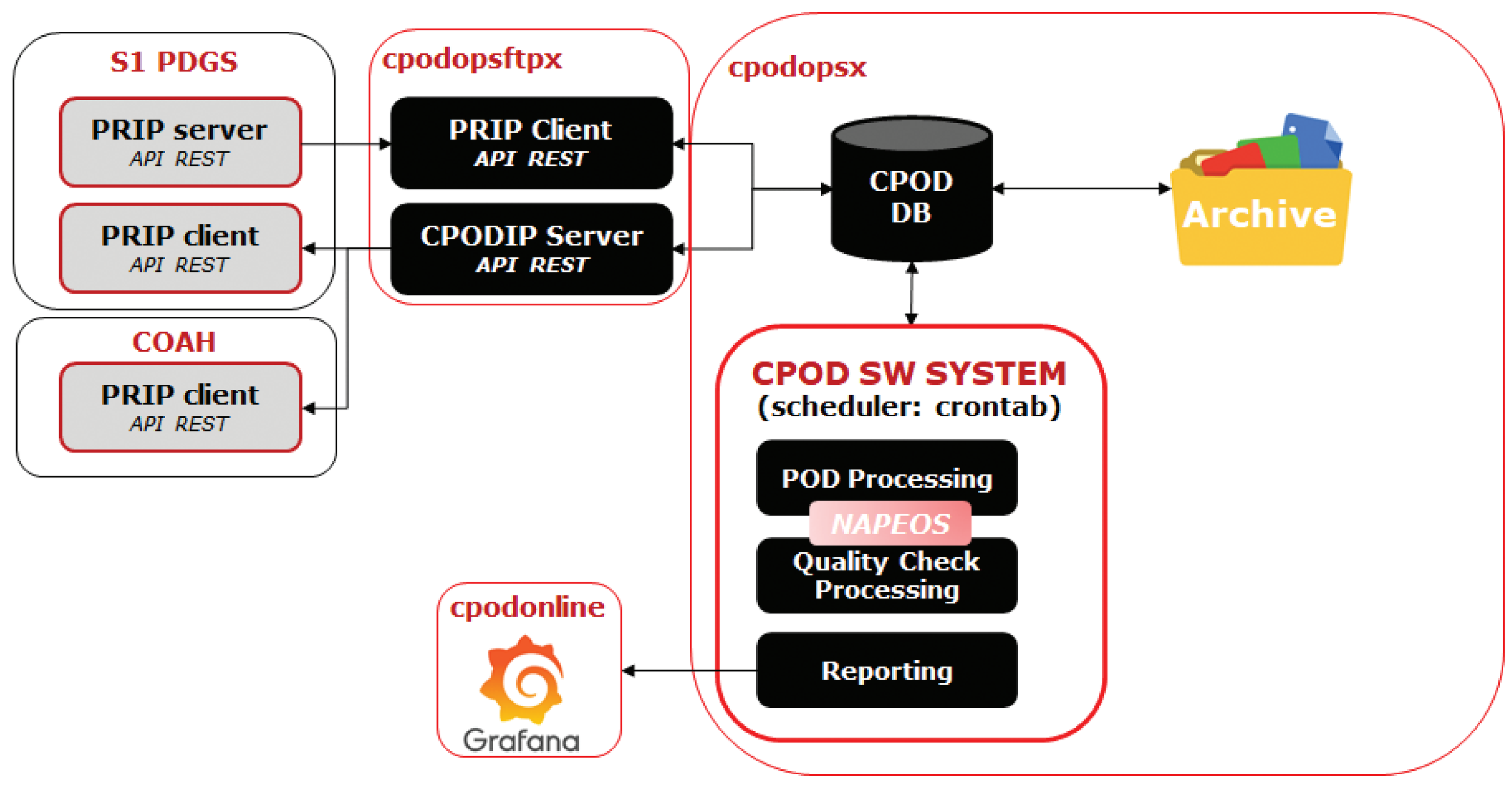
ACCURACY OF SENTINEL-1 POD PRODUCTS



These plots show the current performance of the Sentinel-1 products, when compared against a combined solution computed as a weighted mean of several independent solutions provided by members of the CPOD QWG: AIUB, CPOD, DLR, ESOC, TU Delft and TU Munich.

Product	Timeliness	Coverage	Accuracy
Predicted orbit	30 / 10 min	4 orbits	100 / 12 cm
Restituted orbit	180 / 9.1 min	2 orbits	10 / 2.8 cm
Precise orbit	20 days	26 hours	5 / 0.6 cm
RINEX daily	3 days	One day	
Quaternions	3 days	One day	

CPOD PROCESSING SCHEME AND PRODUCTS



CPOD Service processing strategy:

- For the predicted (PREORB) and restituted (RESORB) products, which have short timeliness, the CPOD Service triggers the execution of them as soon as a new GNSS L0 dump is downloaded from the PRIP server and archived in the CPOD Service side.
- For the precise (POEORB) products, a scheduler launches the generation at a fix hour, to match the maximum timeliness, to assure that the best GNSS products are used.
- For the RINEX and quaternions, which are disseminated to external users through the Copernicus Open Access Hub (COAH), the scheduler launches their generation three days after the reception of the raw data, to have time to fill potential data gaps.
- The POD processing consists in the following steps:
  - GNSS and Attitude raw decoding.
  - Retrieve and merge the necessary GNSS orbits and clocks from the External GNSS Provider (EGP).
  - Pre-process the GNSS observables to remove outliers and compute an initial orbital solution using a kinematic approach.
  - Compute the precise orbit including the fixing of the carrier phase ambiguities to integer, if there are phase biases.
  - Archive the product and disseminate to the external users through:
    - CPODIP for the S-1 PDGS.
    - COAH for external users.

The main conclusions are:

- The accuracy of the predicted solutions are split into the first and second orbit. They have a good accuracy except when there is high solar activity (the geomagnetic index is represented in the plots of 2022, with a blue line).
- The restituted solutions have a typical accuracy (1-sigma) of less than 3 cm (3D RMS), significantly lower than the required 10 cm.
- The precise solutions have a typical accuracy (1-sigma) of 0.6 cm (3D RMS), significantly lower than the required 5 cm. This accuracy is in line with the published accuracy of the full-mission reprocessing done in 2021 (M. Fernández, H. Peter, et al., Copernicus Sentinel-1 POD reprocessing campaign (2022) Advances in Space Research, https://doi.org/10.1016/j.asr.2022.04.036)).

Acknowledgements

The Copernicus POD Service is financed under ESA contract no. 4000132155/21/I-BG, which is gratefully acknowledged.

The work performed in the frame of this contract is carried out with funding by the European Union. The views expressed herein can in no way be taken to reflect the official opinion of either the European Union or the European Space Agency.

The Copernicus POD Service is grateful to the CPOD QWG members for their support in the validation of the results.

INNOVATING SOLUTIONS