Copernicus POD Service: Status and Challenges

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Ocean Surface Topography Science Team Meeting
Wiesbaden, Germany, 22 June 2026

Agenda

1. Introduction
2. Evolution of the service
3. Next challenges
4. Conclusions

CPOD Service - Introduction

CPOD Service

Copernicus is the European Union's Earth observation programme, looking at our planet and its environment to benefit all European citizens.

European Commission
esa
EUMETSAT
+ others

→ opernicus Europe's eyes on Earth →

COPERNICUS POD Service

More info in:

CPOD CONSORTIUM
gmv INNOVATING SOLUTIONS
PosiTIM
DLR TU Delft
GFZ TUM
Helmholtz-Zentrum Potsdam

QWG
CONSORTIUM
+
esa
EUMETSAT
cnes AIUB
GRGS TU Graz
JPL NASA

The **Copernicus POD (CPOD) Service** is responsible for the operational generation of precise orbital and auxiliary products for the Copernicus Sentinel missions.

CPOD Service

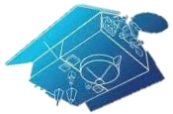
Products

The CPOD Service offers operational support of **altimetry** missions:

Sentinel-3

- CPF prediction files for ILRS
- NRT/STC/NTC orbital products
- NRT/STC/NTC platform data files
- Quaternion files
- GNSS hourly and daily RINEX files

Sentinel-6



- NRT orbital products
- Quaternion files
- GNSS hourly and daily RINEX files

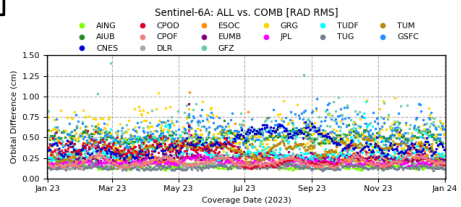
Near-Real Time	Short-Time Critical	Non-Time Critical
		
< 10 min	< 1.5 days	< 25 days
		
< 8 cm (rad) S3 < 5 cm (rad) S6	< 3 cm (rad)	< 2 cm (rad) (S3)

CPOD Service

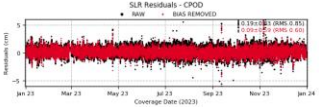
Activities

Generation of **combined solution** (reference for QC)

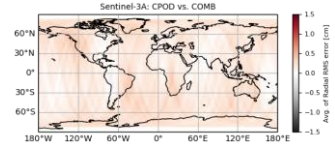
Accuracy & timeliness performance



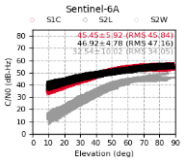
SLR Validation



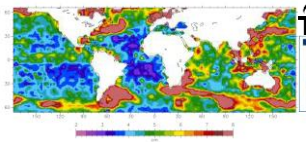
Geographic & Spectral Analyses



GNSS Signals/tracking performance



Altimetry Cross-over Analysis



TU Delft

TUM TECHNISCHE UNIVERSITÄT MÜNCHEN

CPOD Service activities

Operational POD provision

Quality Control & Validation

External user information & POD provision

Improvement of algorithms

Scientific communication

COPERNICUS POD Service

Copernicus Europe's eyes on Earth

esa

POD info

Products

POSITIM DLR GFZ TU Delft TUM

Evolution of the service

CPOD Service evolutions

Summary

- Distribution of **CPOD QWG COMB TDS** with orbits in CoM and CoN in August 2024.
- ...
- Application of **ITRF20 SGM** on operational products since March 2025.
- New satellites! **Sentinel-1D** and **-6B** launched in November 2025.
- Major evolution of **EGP** (GMV GSharp) & **ambiguity-fixed STC** solutions since March 2026.
- Recalibration of **PCOs** & **PCVs** for S-3AB nom/red, -1C red, -1D nom/red in April 2026.

CPOD Service evolutions

ITRF20 SGM (I)

- The **CPOD Service** kindly requested the **user community** to understand and analyse the differences explained in the TN (GMV-CPOD3-MEM-0018_v1.0_CPOD QWG COMB TDS).
- **ESA/EUMETSAT**, following the **CPOD QWG** recommendation, approved the application of **ITRF20 Seasonal Geocenter Motion** model to operational products since CPOD v3.11.0 (March 2025).
- **Improved consistency** w.r.t. rest of solutions (in particular CNES POE-G standards).

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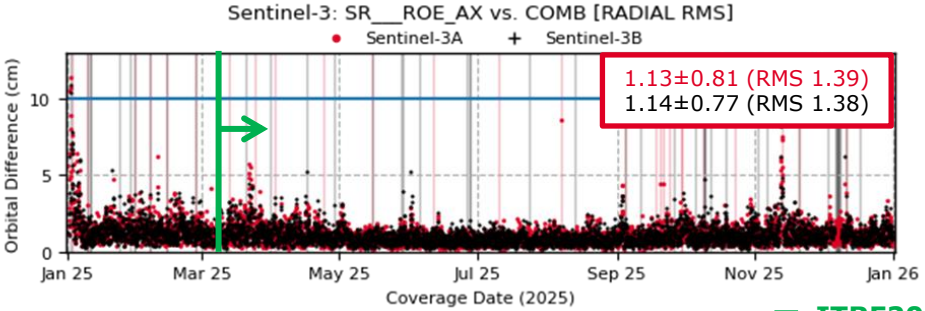
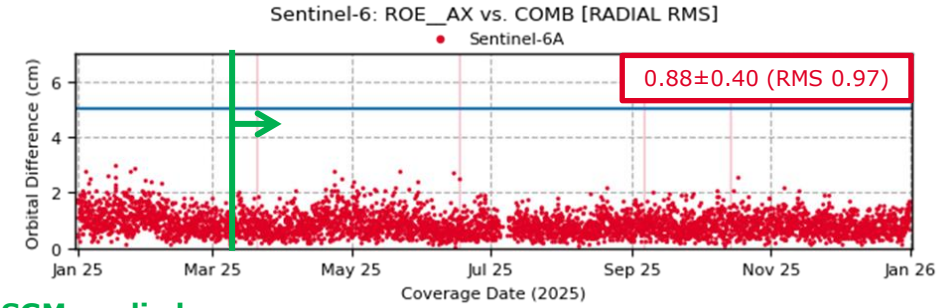
02/08/2024

Memo:	CPOD QWG COMB TDS
From:	M. A. Muñoz, CPOD Team
To:	ESA / EUMETSAT / CPOD QWG
Distribution:	Pierre.Femenias@esa.int, Muriel.Pinheir Carolina.NogueiraLoddo@eumetsat.int, copernicuspod@gmv.com, Heike.Peter@
Subject:	CPOD QWG COMB TDS
Ref.:	GMV-CPOD3-MEM-0018 v1.1
ESA contract number:	4000139509/22/I-BG



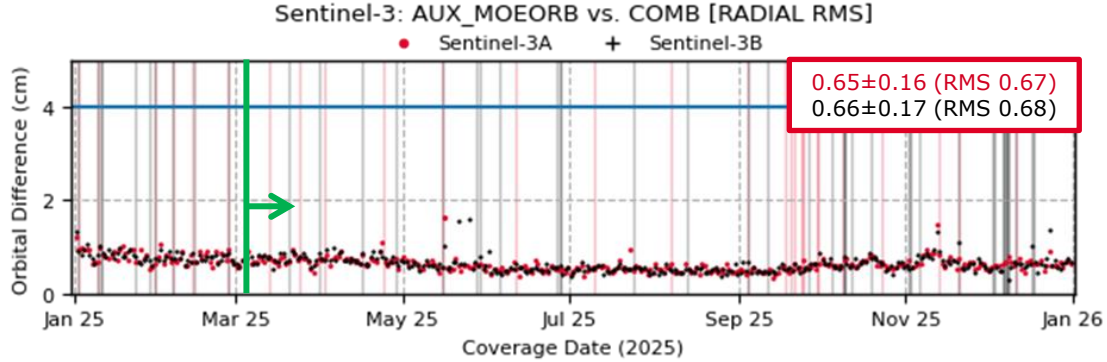


ITRF20 SGM applied

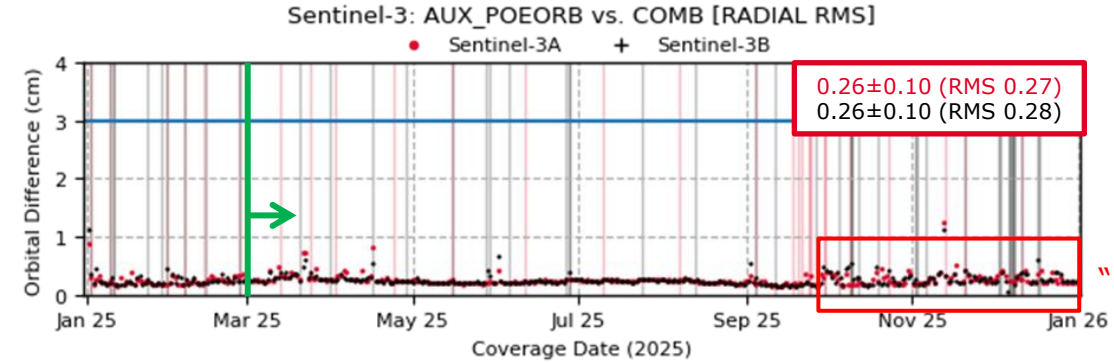
CPOD Service evolutions

ITRF20 SGM (II)

S3 STC



S3 NTC



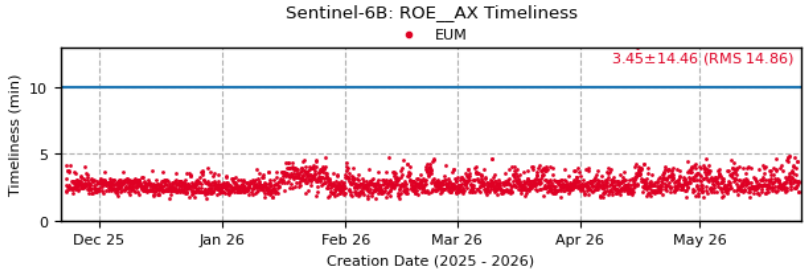
■ **ITRF20 SGM applied**

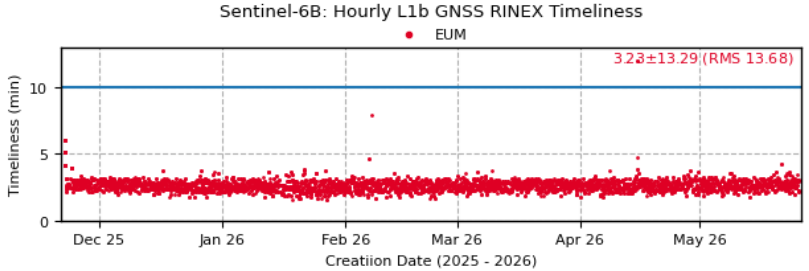
Dispersion due to bug in "unfixable ambiguities" in CPOD v3.13; corrected in Jan'26

CPOD Service evolutions

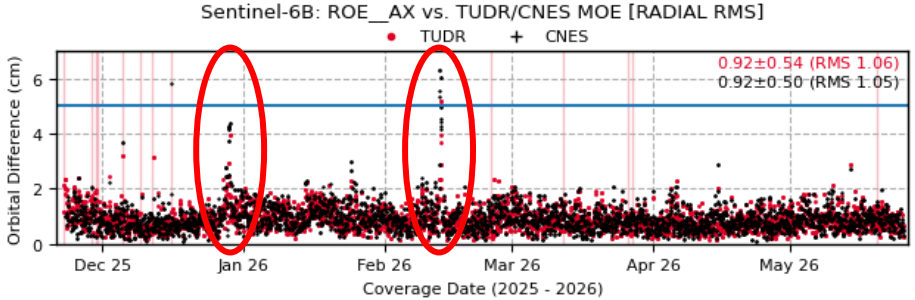
Sentinel-6B status

- Operational interfaces exercised **automatically since 22/11/2025**, with first GNSS L0 data reception.
- **Nominal timeliness** of ROE and GNSS RINEX files.





- **Nominal orbital accuracy** except for **2 anomalous points → possible outgassing events?**



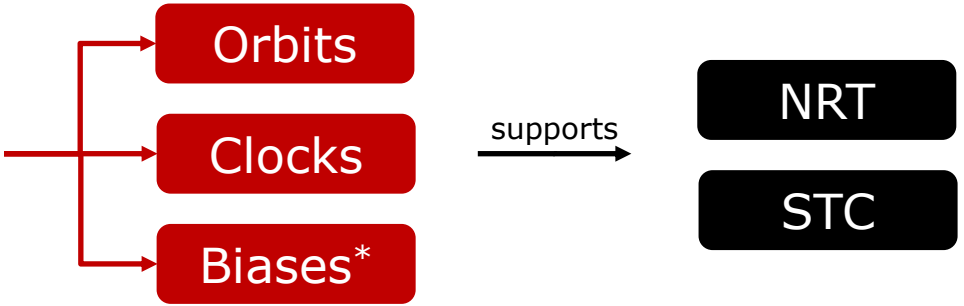
See poster:
COPERNICUS POD SERVICE: S6B OPERATIONAL STATUS AND FIRST PERFORMANCE ASSESSMENT

CPOD Service evolutions

EGP evolutions

GMV GSharp®

SAFE HIGH-ACCURACY RELIABLE POSITIONING SOLUTION



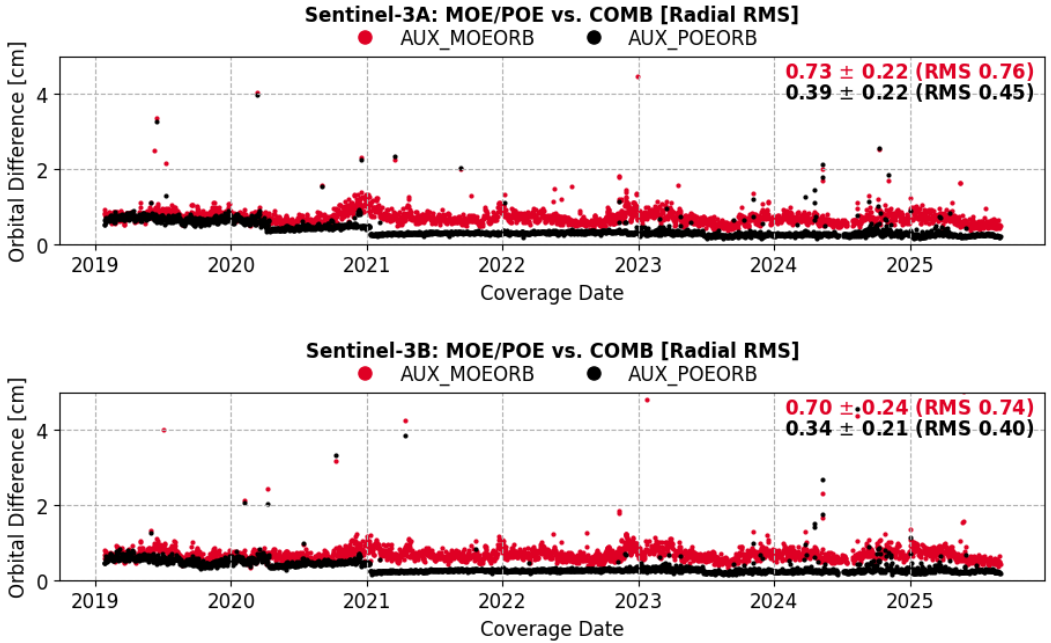
* < 03/26: DCBs; ≥ 03/26: +OSBs

- Major **evolutions**, deployed w/ *CPOD v4.0.0* (March 2026):
  - Algorithmic:
    - Addition of absolute code and phase biases in STC.
  - Infrastructure:
    - New cloud provider based on AWS, with nodes in EU and US.
    - GNSS stations from commercial contracts w/ GMV, rather than relying on IGS public data; ties kept to IGS via reference clock from master IGS stations.

CPOD Service evolutions

EGP evolutions: Ambiguity Fixing in STC (I)

- **Objective**: bring MOE accuracy closer to POE



MOE vs POE differ in:
- Accuracy of GNSS inputs (orb, clk)
- Ambiguity Fixing

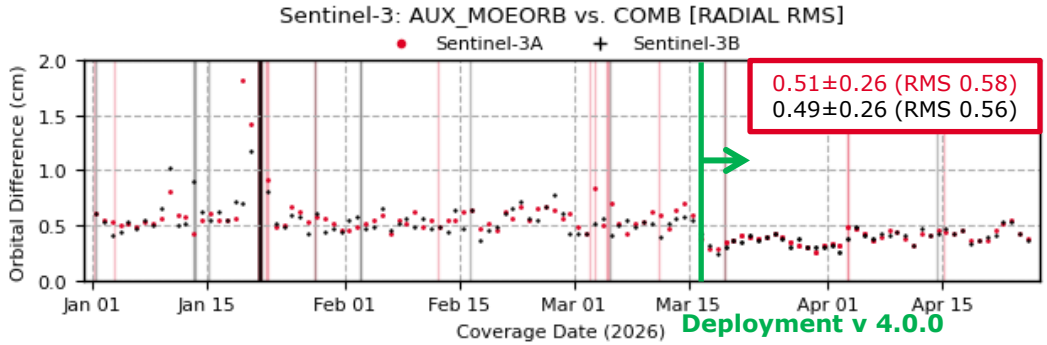
CPOD Service evolutions

EGP evolutions: Ambiguity Fixing in STC (II)

- **Validation**: offline comparisons vs COMB + "operational" validation for ~1 month.
- **Deploy**: following more extensive validation (see *GMV-CPOD3-MEM-0032 Validation of GSharp Modifications and Integration of IAR into STC Processing in QR*) and green light from ESA/EUM teams, changes deployed operationally on **16/03/2026 w/ CPOD v4.0.0**.
- **Expectations**: Visible improvement of MOE accuracy and stability.

30/01/2026

Memo:	Validation of GSharp Modifications and Inte
From:	M. A. Muñoz, CPOD Team
To:	ESA / EUMETSAT / CPOD QWG
Distribution:	Muriel.Pinheiro@esa.int, Carolina.Nogueira francisco.sancho@eumetsat.int, copernicus CPOD QWG
Subject:	Validation of GSharp Modifications and Inte
Ref.:	GMV-CPOD3-MEM-0032 v1.0
ESA contract number:	4000139509/22/I-BG

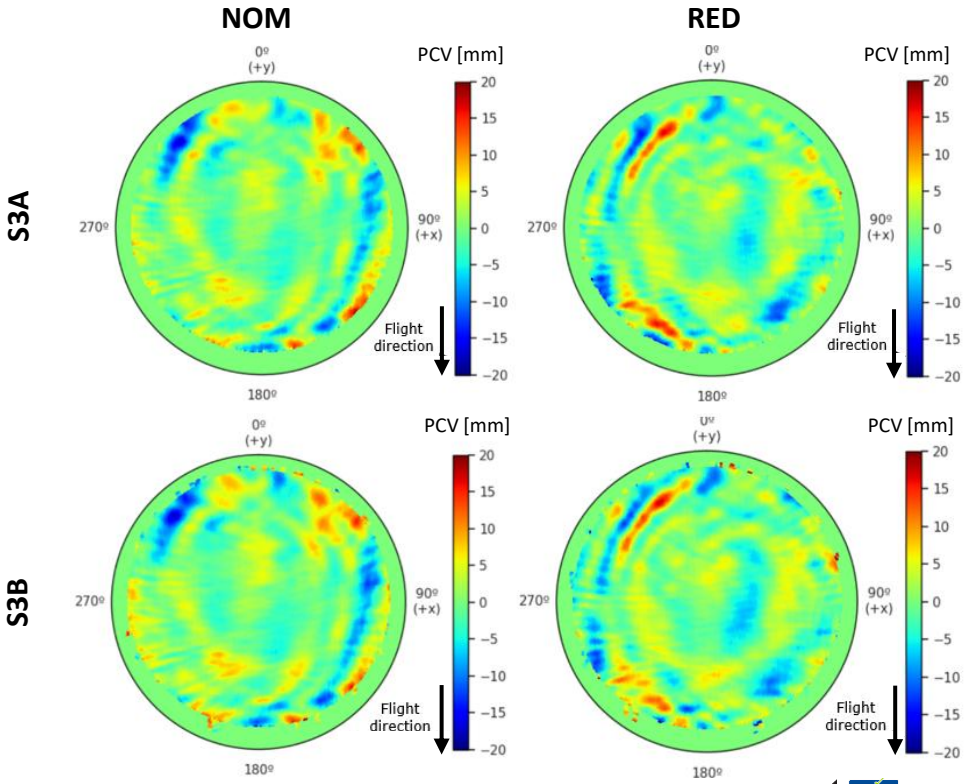


CPOD Service evolutions

Calibration of Sentinel-3A/B nominal and redundant receivers

- Following the CPOD QWG recommendation, the **redundant** receiver of both Sentinel-3A and -3B was activated during the summer'25 for almost 2 months in parallel to the nominal receiver, which remained in control, for **calibration purposes**.
- **Operational anomalies** on both S-3A and S-3B towards the end of 2025 and the beginning of 2026 proved the **value** of redundant GNSS units to ensure continuity of operations.

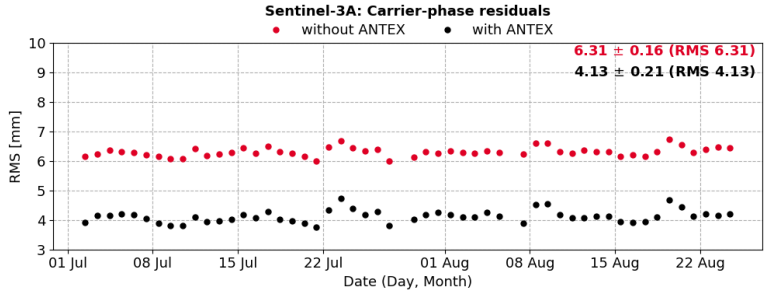
		PCO – North/East/Up [mm] for GPS L1/L2	
Satellite	**Receiver**	**Initial**	**Final**
S-3A	**NOM**	0/0/68.00	0/0/79.26
	RED	0/0/68.00	0/0/79.26
S-3B	**NOM**	0/0/68.00	0/0/77.03
	RED	0/0/68.00	0/0/77.00

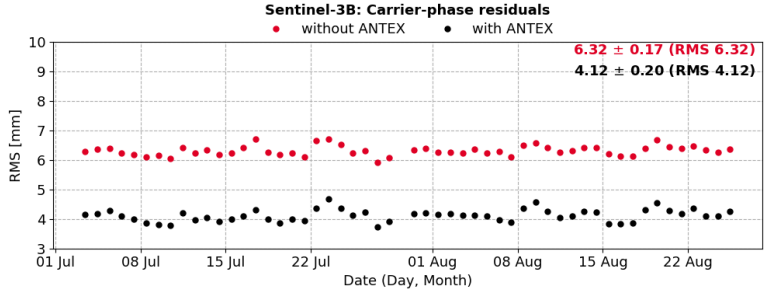


CPOD Service evolutions

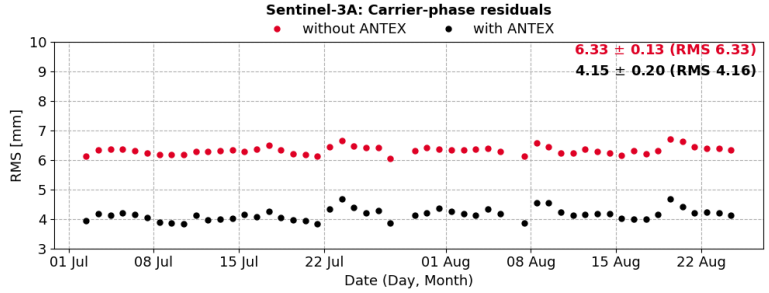
Calibration of Sentinel-3A/B nominal and redundant receivers

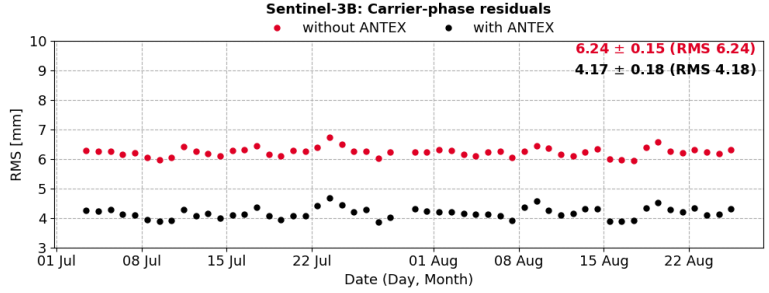
NOM





RED





- Further analyses have shown that the **orbit** as seen by both receivers is **consistent** to the 1-mm level ☺

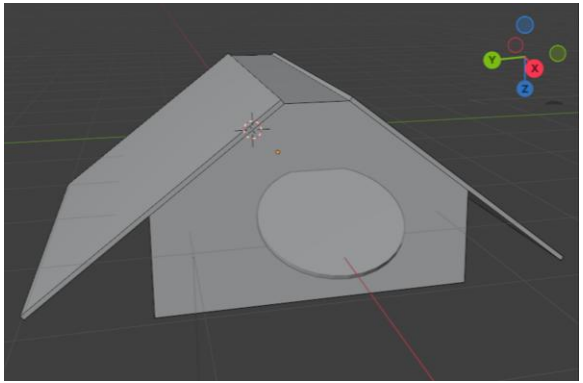
Next challenges

Next challenges

Geometric Radiation Pressure Modelling

- **Modelling of radiation pressure forces** is challenging for spacecrafts with complex geometries such as **Sentinel-6:** conventional macro-models are insufficient.

- Alternative modelling approach using **GMV GRIAL** tool, which computes radiation forces **directly from a CAD model:**



See full analysis on poster:
COPERNICUS POD SERVICE: RADIATION MODELLING BASED ON 3D MODEL

- **First results** show a **limited reduction in empirical accelerations** but highlight a **strong sensitivity to geometry** and surface properties: **need for accurate inputs from industry**.

Next challenges

Operations

- Prepare system for **Sentinel-3C** and **3-unit** parallel operations → almost ready!! ☺
- Improve **operational robustness**: high solar activity, more frequent manoeuvres, resilience to on-board issues (switches back and forth GNSS-1 and GNSS-2, science data disruption, resets…), better near-real time quality flagging… → (*ad aeternum*) work in progress

Conclusions

Conclusions

- The CPOD Service has maintained the **state-of-the-art** performance of its products and has continued to work on evolutions to keep pushing the boundaries.
- The main algorithmic improvement has been the application of **ambiguity fixing** to **STC**, thanks to the evolutions of the EGP.
- In addition, following the recommendation of the QWG, the CPOD Service has included the **ITRF2020 SGM** model across all operational processing chains, improving consistency among the different solutions.
- The **next challenges** we will focus on include the adaptation to the 3-unit scenario, incorporating Sentinel-3C; and the improvement of quality flagging and robustness to degraded scenarios

Thank you

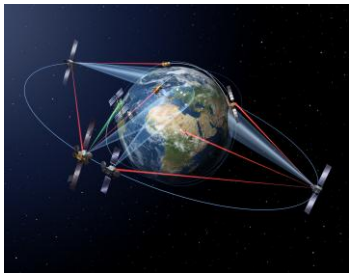
Copernicus POD Service

Miguel Ángel Muñoz (GMV)
Carlos Fernández(GMV)
Marc Fernández (GMV)
Heike Peter (POSITIM)
Muriel Pinheiro (ESA/ESRIN)
Carolina Nogueira Loddo (EUMETSAT)

WHAT IS FocusPOD?

- ***FocusPOD*** is a set of tools powered by the MAORI library.
- ***GMV MAORI*** (**M**ulti-purpose **A**dvanced **O**rbit **R**estitution **I**nfrastructure), is a **new** GMV Flight Dynamics library, written in **C++** from scratch, using state-of-the-art software development paradigms and astrodynamics algorithms, which allows the development of **advanced Flight Dynamics applications** in the areas of:
  - Precise Orbit Determination (POD) and Geodesy.
  - Space Flight Dynamics (FD) / Interplanetary.
  - Space Surveillance and Tracking (SST) / Space Traffic Management.
  - Mission Analysis and Simulation.

Further information: *FocusPOD, a new operational geodesy tool*

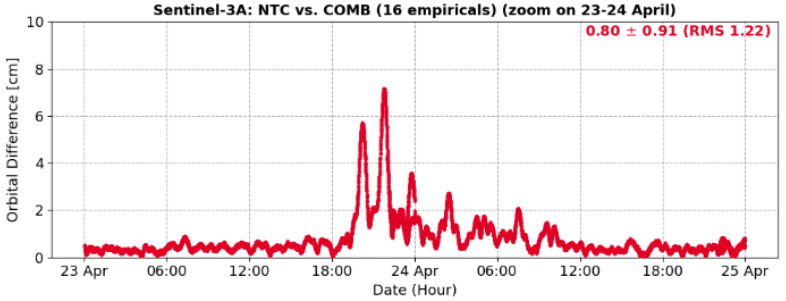



Ongoing activities

High solar activity

- We are in the middle of a peak of **high solar activity**, implying more frequent CME (coronal mass ejections) and causing geomagnetic storms.
- This impacts **LEO POD** mainly because atmospheric disturbances induce rapid changes in the atmosphere density, causing degradations in the drag modelling, as well as augment ionospheric scintillations, increasing the SNR of GNSS signals.
- **S-1A PREORB** parametrisation was modified in Apr'24 to **mitigate these effects**.
- Similar analyses were performed for **Sentinel-3**, but no operational change was triggered so far.

OPS



TEST