Copernicus POD Service

Copernicus S-3 POD Performance of operational products

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7th Sentinel-3 Validation Team Meeting, ESRIN, Italy

18-20 October 2022













Agenda

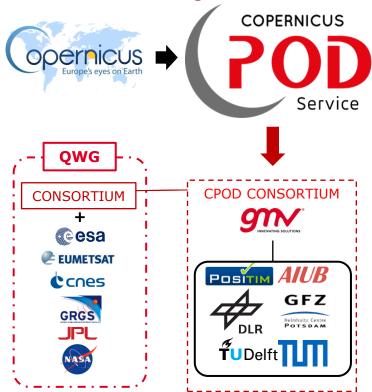
- 1. Introduction to Copernicus POD Service
- 2. Performance of operational products
- 3. Next steps

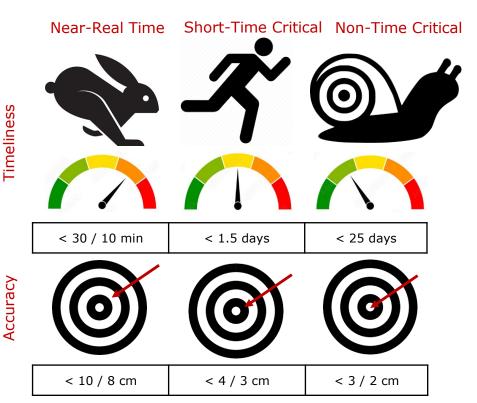


INTRODUCTION



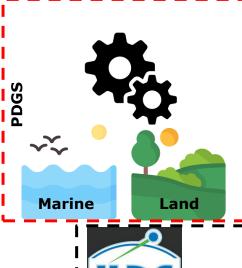
PRODUCTS AND REQUIREMENTS







PRODUCTS AND REQUIREMENTS



Orbits

NRT (10 min) STC (36 h) NTC (25 d) Platform / Attitude



NRT (10 min) STC (36 h) NTC (25 d) **GNSS Observations**



Hourly Daily



CPF CPF



NRT (10 min) STC (36 h) NTC (25 d)

QUAT Daily

Daily

PHYSICAL ARCHITECTURE





10 Machines 80 CPU Cores

120 GB RAM MEMORY

1.2 TB Hard disk memory 10 TB Archive Space

4 Missions (S1, S2, S3, S6)

Satellites (S-X A/B) Timeliness (PRE, NRT, STC, NTC)

100,000 Orbital products/year



QUALITY WORKING GROUP - COMBINED SOLUTION



1st Step: Unweighted Mean

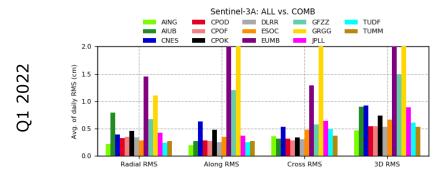
$$\mathbf{SV}_{comb_0}(t^*) = \frac{\sum_{j} \mathbf{SV}_{j}(t^*)}{\sum_{j} 1} -$$

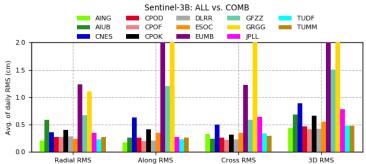
2nd Step: Daily weights as median of distances

$$\mathbf{SV}_{comb_0}(t^*) = \frac{\sum_{j} \mathbf{SV}_{j}(t^*)}{\sum_{j} 1} \longrightarrow w_{j} = median \left| \mathbf{SV}_{comb_0}(t^*) - \mathbf{r}_{j}(t^*) \right| \longrightarrow \mathbf{SV}_{comb}(t^*) = \frac{\sum_{j} \mathbf{SV}_{j}(t^*)/w_{j}}{\sum_{j} 1/w_{j}}$$

2nd Step: Weighted Mean

$$\mathbf{SV}_{comb}(t^*) = \frac{\sum_{j} \mathbf{SV}_{j}(t^*)/w}{\sum_{j} 1/w_{j}}$$





SENTINEL-3 POD MODELLING



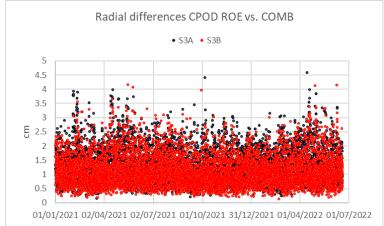
Model	Value	
EOPs	IERS rapid / finals	
Reference System	IERS standards	
Gravity field	Current: EIGEN.GRGS.RL04 TVG Future: COSTG	
Solid tides	IERS 2010	
Ocean tides	FES 2014	
Atmospheric gravity	GFZ AOD L1B RL06	
Earth / Ocean pole tides	IERS 2010	
Radiation pressure model	Box-wing	
Earth radiation	Albedo and infra-red applied	
Atmospheric density model	msise00	

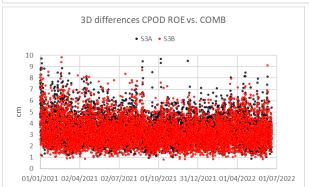
	NRT	STC	NTC
Arc length	24 h	5+24+3 h (32h)	
Drag coefficient	10 (estimated)	1 (estimated)	
Solar pressure coeff.	1 (estimated)	1 (fixed)	
1/rev empiricals (estimated)	2 sets per arc in: along sin+cos cross sin+cos	16 sets per arc in: along cnt+sin+cos cross cnt+sin+cos	
GNSS sampling	30 sec	10 sec	
GNSS products	magicGNSS	magicGNSS	CODE Finals
Receiver ambiguities	Float <i>Future: Fixed</i>	Float <i>Future: Fixed</i>	Fixed
Manoeuvres	Calibrated		



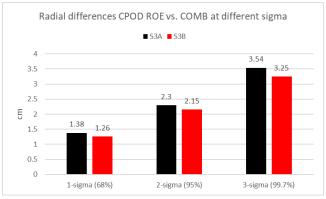


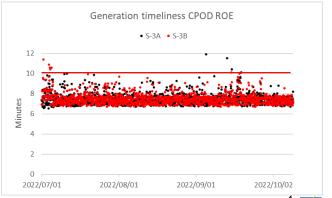
RESTITUTED ORBIT EPEHEMRIS (NRT) - POD



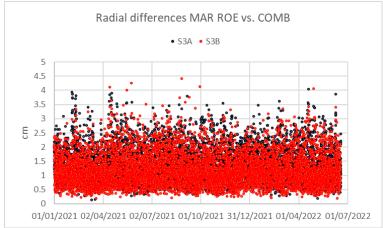


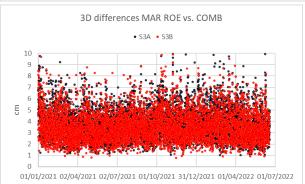




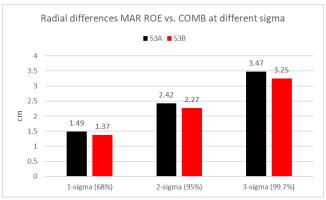


RESTITUTED ORBIT EPEHEMRIS (NRT) - MAR

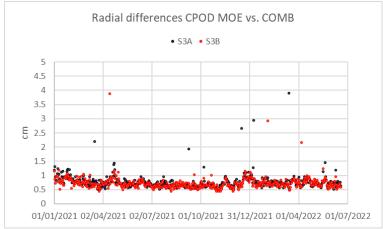


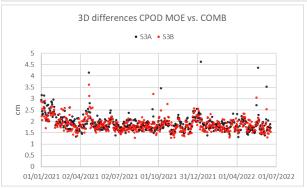




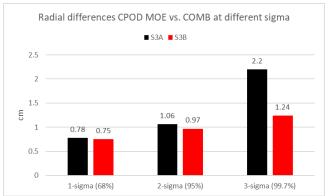


CPOD MEDIUM ORBIT EPEHEMRIS (MOE)





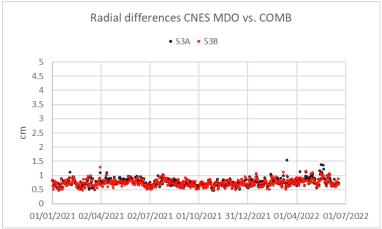


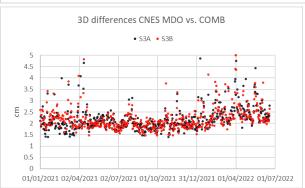


3-sigma impacted by outliers!

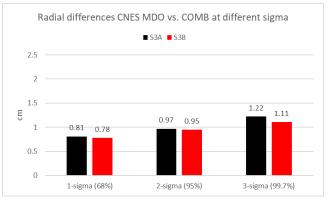


CNES MEDIUM ORBIT EPEHEMRIS (MDO)

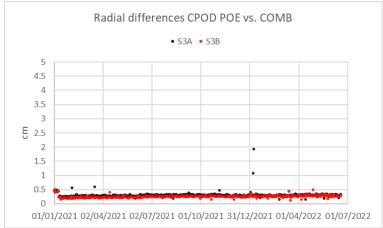


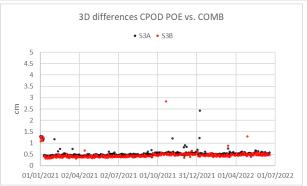




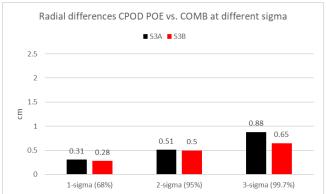


CPOD PRECISE ORBIT EPHEMERIS (POE)





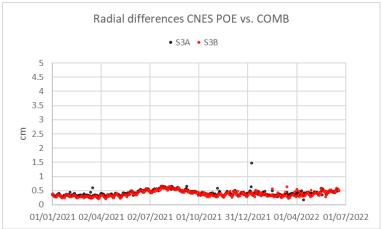


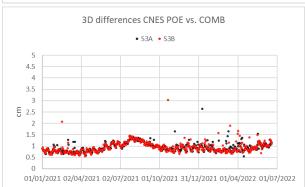


■ Change of parametrization in January 2021

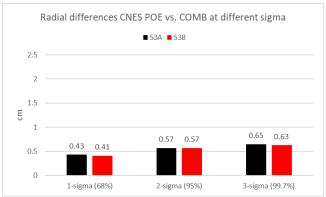


CNES PRECISE ORBIT EPHEMERIS (POE)

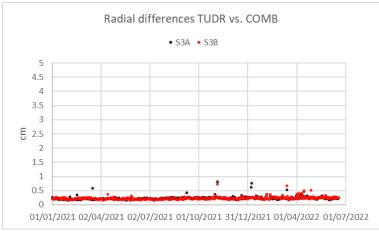


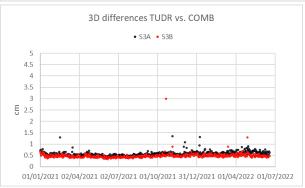




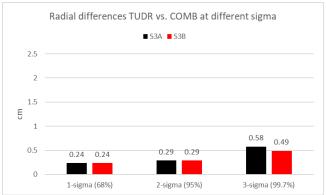


TUD RAPID







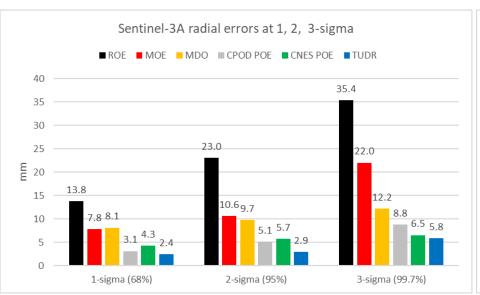


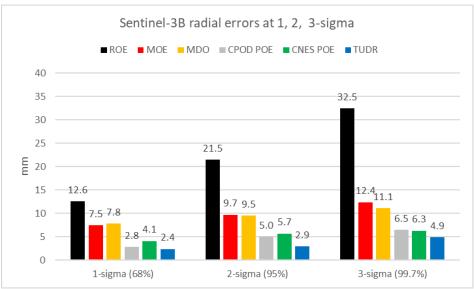
- Generated by TU Delft for QC purposes
- @ 18 20h of next day
- Makes use of Integer Ambiguity Resolution



SUMMARY OF RADIAL ERRORS









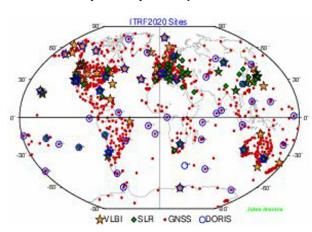
ITRF 20



- WHAT: New realization of the International Terrestrial Reference Frame (ITRF). Impacts:
 - > IGS: New mean pole model
 - > IGS: New GNSS PCO/PCV (ANTEX); Galileo fixed
 - > IGS: New GNSS orbits, clocks and biases; long filenames
 - IGS: New EOPs / ERPs (finals2000A.data)?
 - > ILRS: New SLR station's coordinates
 - IDS: New DORIS station's coordinates
 - CPOD: New Sentinels PCV map (ANTEX)
 - CPOD/EGP: New GNSS orbits and clocks
- WHEN: 27/11/2022
- WHY: Periodic realization of ITRF: 94, 96, 97, 2000, 05, 08, 14, 20

IMPACT:

- Careful orchestration to use ITRF products on NRT / STC / NTC
- Need of reprocessing?



focusPOD



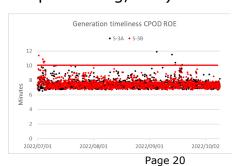
focusPOD vs COMB

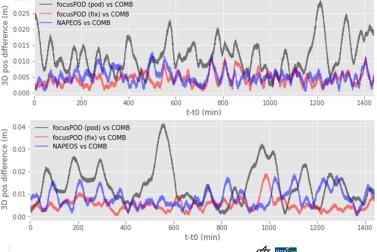
(3D RMS)

4.7 mm

5.8 mm

- WHAT: substitution of NAPEOS with focusPOD, a new GMV's POD SW
 - Written from scratch in C++ / Python
 - Designed as a library
 - Developed to keep same performance (accuracy & timeliness)
- WHEN: 31/12/2022
- WHY:
 - Required by the CPOD#3 ITT (no more ESA's CFIs)
 - > To enhance performance (timeliness, accuracy, manoeuvres)
 - Develop service/micro-service architectures
 - Future developments (raw & network processing, etc.)
- IMPACT:
 - > Transparent to final users
 - Validation period: Nov+Dec 2022





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NAPEOS VS COMB

(3D RMS)

5.4 mm

9.0 mm

Satellite

S-3A (GPS)

S-6A (GAL)

USE OF COST-G



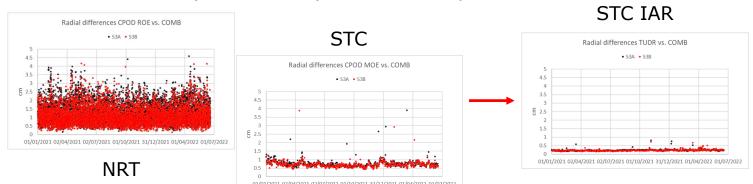
- WHAT: International Combination Service for Time-variable Gravity Fields (COST-G)
 - https://cost-g.org/
 - > See next presentation (Copernicus Sentinel-3 POD with COST-G)
- WHEN: First half of 2023 (To be agreed by CPOD QWG)
- WHY: To improve the accuracy and stability of products
- IMPACT:
 - Better accuracy and stability of orbital products
 - To update the geopotential quarterly
 - Dependency with COST-G



IAR in STC / NRT



- WHAT: Integer Ambiguity Resolution in shorter timeliness
 - Use GNSS biases from EGP on STC/NRT POD
 - Enhance robustness of STC/NRT POD
 - > Exhaustive experimentation to confirm expected results
- WHEN: First half of 2023; first in STC, then in NRT
- WHY: To improve the accuracy and stability of products
- IMPACT: Better accuracy and stability of STC / NRT products



REDESIGN OF CPOD SERVICE



External data (e.g. EOPs, solmag)

Input/Output files

WHAT:

> To enhance the use of DBs to archive processing metrics, QC, monitoring.

> To orchestrate processing using a modern service or micro-service architecture.

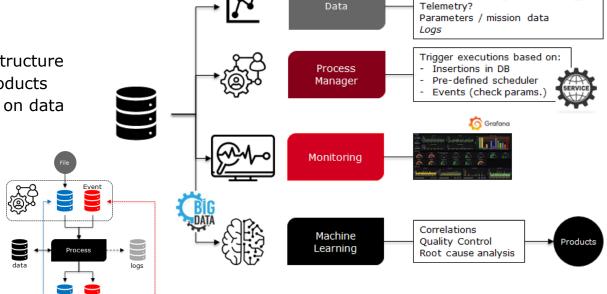
WHEN: 2023

WHY:

- To optimize the hardware infrastructure
- To improve the timeliness of products
- > To develop new products based on data

IMPACT:

- Better timeliness of products
- Better quality control
- More data to exploit



CONCLUSIONS



CONCLUSIONS



- Mature service: +8 years of continuous operations
- Significant improvement of accuracy and timeliness with respect to original requirements
- Big changes in the following month / year: ITRF20, focusPOD, COST-G, IAR, DBs & Services

Thank you

Copernicus POD Service

Jaime Fernández (GMV)

Carlos Fernández (GMV)
Pierre Féménias (ESA/ESRIN)
Carolina Nogueira Loddo (EUMETSAT)









